TEACHERS' USE OF CHILDREN'S LITERATURE, MATHEMATICS MANIPULATIVES, AND SCAFFOLDING TO IMPROVE PRESCHOOL MATHEMATICS ACHIEVEMENT: DOES IT WORK?

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Dissertation Prepared for the Degree of

DOCTOR OF EDUCATION

UNIVERSITY OF NORTH TEXAS

December 2000

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Bennett, Tisha L., Teachers' Use of Children's Literature, Mathematics Manipulatives, and Scaffolding to Improve Preschool Mathematics Achievement: Does It Work? Doctor of Education, (Early Childhood Education), December 2000, 135 pp., 6 tables, reference list, 126 titles.

The primary purpose of this study was to determine if the implementation of an intervention involving teachers' use of children's literature, related storybook manipulatives, and a scaffolding (LMS) approach to learning would improve preschool children's mathematics test scores. Additionally, the LMS approach was examined to determine whether teachers' perceptions of their effectiveness in mathematics instruction changed from the beginning to the end of the study.

The subjects of the study included 60 preschool-aged children and six teachers from two child care centers. The preschool teachers participated in either a control or experimental condition (the LMS approach) in their daily mathematics instruction with their preschool children. The researcher tested the children using the Test of Early Mathematics Ability and an abbreviated version of the Stanford-Binet Intelligence Scale.

The study was based on two main research questions. The first question asked if there was a difference in the Test of Early Mathematics Ability total posttest scores between children in the literature-manipulatives-scaffolding intervention group and children in the control group after assuring equivalency of the two groups. The second question addressed if preschool teachers believed they were more effective in their mathematics instruction after implementing the LMS approach with young children.

The answer to the first research question was that there was no statistically significant difference in the Test of Early Mathematics Ability total posttest scores between children in the literature-manipulatives-scaffolding group and children in the control group. However, the answer to the second question was that preschool teachers believed they were more effective in their mathematics instruction after implementing the LMS approach with young children.

Recommendations for future research on early childhood mathematics include the investigation of preschool children's ability, achievement, and interest in mathematics; teachers' use of mathematics scaffolding techniques; and longitudinal mathematics interventions beginning during the preschool years.

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CHAPTER I

Introduction

During the early 1980s, a seminal report, A Nation at Risk, by the National Commission on Excellence in Education and Secretary of Education T. H. Bell affirmed the public's increasing awareness of a range of critical national issues facing education (National Commission on Excellence in Education, 1983). These issues included concerns about students' low academic performance, especially in science and mathematics, and workers' skills lagging behind technological changes in the workplace ("The Condition of Education," 1996). The concern expressed in the 1980s has continued throughout the 1990s into 2000, with renewed importance on academic standards and achievement of today's students. The current focus on standards has serious implications, not only for schools but also for the future of individual citizens, U.S. economic competitiveness, and ultimately the structure and cohesiveness of American society and culture ("The Condition of Education," 1996).

In recent years, the world has changed through globalization and the increased use of technology (U.S. Department of Labor, 1999). Changes in today's world have precipitated changes in work and the workplace. According to the U.S. Departments of Education and Labor (1999), 56% of employers have noted that the skill requirements of their workers are increasing. Moreover, employers have suggested that one out of every five workers is not proficient on the job. Secada (1990) emphasized that the demands of our civilian workforce, military, and government clarify the growing need for everyone educated in our schools today to possess better mathematical and scientific skills: "The mathematical ignorance of our citizenry seriously handicaps our nation in a competitive and increasingly technological global marketplace" (Battista, 1999, p.2).

Just as workplaces have been redefined to address changes in the global and technological world of work, schools must determine how to better prepare students for life and work in a global and technologically literate society. For more than a decade educational reform and its relationship to America's place in the world has been atop the public agenda (U.S. Department of Labor, 1999). Furthermore, schools have been putting forth efforts to better prepare students for work and life in an ever-changing and challenging society. Even so, the U.S. Department of Labor asserted that educational practice throughout our nation has not changed fast enough to strengthen the work readiness or employability skills of our current students. Researchers and educators remain steadfast in their endeavors to explore ways in which schools can better prepare students in science and mathematics for the present technologically literate society.

Legislation and publications over the last 20 years show the importance that the United States government and professional organizations have placed on mathematics and science achievement (McDonnell, McLaughlin, & Morison, 1997). In 1979-1980, President Carter appointed committees to assess students' competency and the adequacy of foreign language, science, and engineering education. The study of foreign language was decreasing, and there was a reported "…trend toward virtual scientific and technological illiteracy" (Ravitch, 1995, p. 5). During the 1980's various reports condemned the state of education in the United States and called for reform especially in the area of mathematics education (Baroody, 1993; Edwards, 1994). Reports such as A Nation at Risk (National Commission on Excellence in Education, 1983) and A Report on the Crisis in Mathematics and Science Education (American Association for the Advancement of Science, 1984) focused attention on the impending educational crisis, particularly in mathematics and science (Edwards, 1994).

By the later 1980s and early 1990s, various publications were offering new visions of the nature of mathematics education, including early childhood mathematics education (Baroody, 1993). These mathematics-related publications included Curriculum and Evaluation Standards for School Mathematics (National Council of Teachers of Mathematics [NCTM], 1989), Everybody Counts (National Research Council, 1989), New Directions for Elementary School Mathematics: 1989 National Council of Teachers of Mathematics Yearbook (Trafton & Shulte, 1989), Reshaping School Mathematics: A Philosophy and Framework for Curriculum (Mathematical Science Education Board of the National Research Council, 1990), and Teaching and Learning Mathematics in the 1990's (Cooney & Hirsch, 1990).

In 1988-1989, President Bush promised to be "the Education President" (Ravitch, 1995). President Bush and the nation's governors convened an education summit in 1989 (Bush, 1991) and agreed to establish ambitious national educational goals. The president and the nation's governors agreed to six national goals in education to be achieved by the year 2000 appropriately named America 2000: Excellence in Education Act (Bush, 1991). By the year 2000:

1. All children in America will start school ready to learn.
2. The high school graduation rate will increase to at least 90 percent.
3. American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter, including English, mathematics, science, history, and geography; and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy.
4. U.S. students will be first in the world in science and mathematics achievement.
5. Every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.
6. Every school in America will be free of drugs and violence and will offer a disciplined environment conducive to learning. (Bush, 1991, p. 3)

By 1991, President Bush and Secretary of Education Lamar Alexander announced a four-part strategy to attain the six goals set forth in America 2000 (Bush, 1991; Ravitch, 1995). Bush believed that the four-part strategy formed a comprehensive approach to helping communities transform schools and providing all Americans with the best education in the world. The four parts included better and more accountable schools for today's children, a new generation of schools for tomorrow's children, mobilizing all adults to become a nation of students (focus on life-long learning), and creating communities where learning can happen.

In 1994, President Clinton added two new goals to those established in America 2000 and codified the national educational goals as Goals 2000: Educate America Act (McDonnell, McLaughlin, & Morison, 1997). The two new goals focused on teacher education and parental participation and are as follows:

By the year 2000:

1. Teacher Education and Professional Development: The nation's teaching force will have access to programs for the continued improvement of their professional skills and the opportunity to acquire the knowledge and skills needed to… prepare… students for the next century.
2. Parental Participation: Every school will promote partnerships that will increase parental involvement and participation in promoting the social, emotional, and academic growth of children. The Goals 2000 legislation defined eight goals which include school readiness; school completion; student achievement and citizenship; teacher education and professional development; mathematics and science achievement; adult literacy and lifelong learning; safe, disciplined, and alcohol- and drug-free schools; and parental participation. ("Goals 2000," 1998)

Since the early 1980s until today, the incentive to make changes in mathematics education has been high as educators, researchers, politicians, and parents consider the nation to be in an educational crisis (Dehaene, 1997; Price, 1989). U.S. students have compared unfavorably in math and science with students from other industrialized countries for decades (Battista, 1999; Center for the Assessment of Educational Progress, 1989; Stevenson, Lee, & Stigler, 1986). Stevenson et al. (1986) compared young children's mathematics achievement scores and found that by first grade students' scores in the Minneapolis area were below scores of Japanese and Taiwanese students in comparable communities. In 1998, the Third International Mathematics and Science Study (TIMSS), one of the most comprehensive studies ever undertaken of mathematics and science education, reported that American grade 12 students placed near the bottom in comparison with students in other countries studied (Goldman, 1998; "U.S. TIMSS Summary," 1999). Even though the TIMSS found grade 4 students placed above average, the lowered mathematics performance between grades 4 and 8 caused a good deal of uneasiness (Goldman, 1998).

For more than a quarter of a century, the National Assessment of Educational Progress (NAEP) has reported on the educational achievement of students in the United States through "The Nation's Report Card" (Reese, Miller, Mazzeo, & Dossey, 1997). Through the 1970s, student performance generally declined in math and science. Students' scores improved during the 1980s, then remained steady in the 1990s.

The 1996 NAEP mathematics assessment evaluated the educational progress of students at grades 4, 8, and 12 and showed increases in student scores for all three grades levels (Reese, Miller, Mazzeo, & Dossey, 1997). However, in a 1997 press release, U.S. Secretary of Education Richard Riley commented that even though American students have made good progress in math and science since the 1980s, there is still much room for improvement ("Press Release: Trend Report," 1997). Furthermore, not all states and regions of the country showed increases in mathematics performance on the 1996 assessment. For example, while the Southeast and Central regions recorded increases in the average NAEP mathematics scale scores over the period of 1990 to 1996 for all three grades, the Northeast recorded an increase for fourth grade only, and the West showed an increase in twelfth grade only.

Over a decade ago, Price (1989) strongly stated that the mathematics problem in the United States belonged to educators of children all ages. Today the U.S. Department of Education and the National Council of Teachers of Mathematics (NCTM) lead other organizations in emphasizing the importance of clearer mathematics standards and higher mathematics scores for children and youth of all ages. In the summer of 1999, the U.S. Department of Education published a book entitled Early Childhood: Where Learning Begins – Mathematics stressing the importance of mathematics before formal schooling. In 1998, the NCTM began to revise their national standards for students in K-12 schools. The updated NCTM principles and standards will include standards for preschool-age children. Furthermore, in the late 1990s, the Clinton Administration launched a new national mathematics initiative – the America Counts program (Clinton, 1999). Surely, the mathematics problem in the U.S. does belong to educators of children all ages, even early childhood educators.

There is growing awareness of the importance of quality early care and education to children's later development and learning (Kagan & Bowman, 1997). The national educational goals, Goals 2000, not only emphasized mathematics and science achievement but also highlighted a growing national concern: early childhood education. School readiness stood strong as the first of eight goals and stated that “By the year 2000, all children will start school ready to learn” (U.S. Department of Education, 1999).

As of 1995, data from the U.S. Department of Education disclosed that nearly six out of every 10 children under the age of six not in public kindergarten received some type of care or education on a regular basis from someone other than their parents. These numbers translate to 12.9 million infants, toddlers, and preschoolers receiving care and education outside of the home (U.S. Department of Education, 1995). More recently, thousands of children are entering into early childhood settings as their mothers are entering into employment mandated by welfare reform (Kagan & Bowman, 1997). Furthermore, considering that 41 states and the District of Columbia are investing in state pre-kindergarten initiatives (Schulman, Blank, & Ewen, 1999), preschool education is clearly on the forefront of educational policy and research.

Recent political and media attention has renewed public interest in the influence of early childhood programs and interventions on children’s health, well being, and education. Research findings about early brain development, such as the idea of critical or sensitive periods of development related to the acquisition of competencies or skills, are necessary to the future development of the young children (Shore, 1997). In 1994, the Carnegie Corporation of New York released a seminal report, <u>Starting Points: Meeting the Needs of Our Youngest Children</u>. This report noted that rumblings of a “quiet crisis” were beginning to be heard across the United States. This quiet crisis suggested that our nation's children under age three and their families were struggling with a gloomy plight that worsens daily (Carnegie Corporation of New York, 1994). More specifically, this plight involved inadequate prenatal care, isolated parents, substandard childcare, poverty, and insufficient attention to children's development.

Prominent entertainers, including actor Rob Reiner, along with various foundations, corporations, and child development experts, established The "I Am Your Child" campaign, a public awareness campaign designed to enhance the awareness of early brain development (Shore, 1997). Likewise, governors continue to promote quality early childhood initiatives throughout their states. Moreover, in 2000, the National Governors Association adopted a policy on childcare and early education stressing early intervention. Within the preamble to this policy, it was stated that "Cost-benefit research shows that early investment in child development can prevent larger expenses to remediate problems in the future" (National Governors Association, 2000). In a like manner, in 1997, first-lady, Hillary Rodham Clinton commented, "If we invest in the front end of some of these early intervention strategies, I honestly believe that we would not be spending so much money on prisons and mental health and drug abuse treatment" (Education Reporter, 1997, p.1). Price (1989) admonished whenever educators of young children claim that early childhood education reduces problems later in life that the field is accountable to some extent for problems that develop after the early childhood years.

Combining the nation's interest and concern for mathematical literacy with its current focus on early childhood education, mathematics education is now offered to more preschoolers in more formal settings (NCTM, 1998). Jacobson (1998) added that with the number of preschool programs growing and a move in several states toward universal preschool education, the conversation about what preschool children should be learning and how they will learn it will intensify. Additionally, the National Council of Teachers of Mathematics (1998) has maintained that the foundation for children's mathematical development is established between infancy and kindergarten. However, in a study of young children's exposure to math in the child care context, Graham, Nash, & Paul (1997) reported that very little mathematics was presented to children in any of the observed classrooms either directly or indirectly. Baroody (2000) urged teachers of young children to be aware of the impressive informal mathematical strengths of children in their early years and to involve children in a variety of mathematical experiences.

Statement of the Problem

Even though the 1996 NAEP mathematics assessment showed increases in student scores for all three grade levels evaluated (Reese, Miller, Mazzeo, & Dossey, 1997), not all states and regions of the country showed increases in mathematics performance. Further, nearly 40% of U.S. grade 8 students were not achieving at the "basic" level as measured by the NAEP (Reese, Miller, Mazzeo, & Dossey, 1997). Moreover, U.S. students continued to compare unfavorably to students in other countries (Goldman, 1998). According to the Third International Math and Science Study (TIMSS), 55% of U.S. grade 8 students scored below the international average in math ("The Seven Priorities," 1997). U.S. Secretary of Education Richard Riley commented that even though American students have made good progress in math and science since the 1980s, there is still much room for improvement ("Press Release: Trend Report," 1997). The problem of low mathematics achievement is underscored in a document listing the seven priorities of the U.S. Department of Education ("The Seven Priorities," 1997). The second priority of the U.S. Department of Education is for "all students to master challenging mathematics, including the foundations of algebra and geometry, by the end of 8th grade." (p. 1)

The problem facing mathematics education today is that the education of young children does not begin early to address the notion of students mastering challenging mathematics. Copley (1999) stated that even though current research shows that young children are sophisticated mathematical thinkers, most young children are given a rather limited introduction to mathematics before they enter elementary school. Baroody (2000) recently added that preschoolers have impressive informal mathematical strengths in a variety of areas and it makes sense to involve preschool children in engaging, appropriate, and challenging mathematical activities. Hence, a question underlying the problem of low mathematics achievement is, "Can children reach and master challenging mathematics without a firm and early foundation in the subject area?"

Purpose of the Study

Today the U.S. Department of Education and the National Council of Teachers of Mathematics (NCTM) lead other organizations in emphasizing the importance of clearer mathematics standards and higher mathematics scores for children and youth of all ages. Mathematics provides many of the underpinnings for students to navigate the present and ever changing technological and information age ("An Action Strategy," 1998), and the foundation for children's mathematical development is established early in children's lives (NCTM, 1998). In the last 20 years, research on children's knowledge and learning of mathematics has seen a significant reconceptualization of the nature of early mathematical knowledge attributing much more mathematical knowledge and understanding to young children (Baroody, 2000; NCTM, 1998; Resnick, 1989). Along with the attribution of more mathematical knowledge and understanding to young children, educators have become more interested in the classroom connections between children's literature and mathematics.

With the increased support from professional literature related to the literature-mathematics connection, the lack of recent empirical studies showing a connection between children's literature and mathematics instruction in the early childhood classroom is surprising (Copley, 1999; Hong, 1996). Also, little is known about the effectiveness of instructional practices, or teaching methods, utilized in bringing together children's literature and mathematics to foster mathematics achievement. Furthermore, relatively few researchers have tested the hypothesis that reading quality children's literature improves mathematics achievement (Hong, 1996; Jennings, Jennings, Richey, & Dixon-Krauss, 1992). Therefore, the primary purpose of the present study was to determine if the implementation of an intervention consisting of teachers' use of children's literature, related storybook manipulatives, and a scaffolding approach to learning would improve preschool children's mathematics test scores.

Research Questions

1. Is there a difference in the Test of Early Mathematics Ability (TEMA) total posttest scores between children in the literature-manipulatives-scaffolding (LMS)

intervention group and children in the control group after assuring equivalency of the two groups on the TEMA pretest and IQ variables prior to the collection of TEMA posttest data?

2. Do preschool teachers believe they are more effective in their mathematics instruction after implementing the LMS approach with young children?

There are four important terms used throughout this study: mathematics, manipulatives, scaffolding, and zone of proximal development. Each is defined here in Chapter 1 to give clarity of meaning to these central terms. Further, two of the four terms, scaffolding and zone of proximal development, are basic to the theoretical foundation of the study and are discussed in that context in Chapter 3.

Definition of Terms

1. Mathematics – traditionally described as the science of number and shape. Throughout history, school mathematics has emphasized arithmetic and geometry (Steen, 1990). More recently, a broader perspective has defined mathematics (Battista, 1999). In 1989, the National Research Council described mathematics as far more than calculation. Mathematics involved clarification of the problem, deduction of consequences, formulation of alternatives, and development of appropriate tools as part of the modern mathematician's craft. Battista's (1999) definition gives a full description of what mathematics is today and how it is used within the present study:

    > Mathematics is first and foremost a form of reasoning. In the context of reasoning analytically about particular types of quantitative and spatial phenomena, mathematics consists of thinking in a logical manner, formulating and testing

conjectures, making sense of things, and forming and justifying judgments, inferences, and conclusions. We do mathematics when we recognize and describe patterns; construct physical and/or conceptual models of phenomena; create symbol systems to help us represent, manipulate, and reflect on ideas; and invent procedures to solve problems. (p. 5)

2. Manipulatives – concrete objects used to enhance the learning of mathematical concepts. Clements (1999) stated that good manipulatives are those that aid students in building, strengthening, and connecting various representations of mathematical ideas. Since the 1940s, The National Council for Teachers of Mathematics has advocated for the use of concrete objects, referred to as manipulatives, as a means of introducing mathematical concepts and skills to children (Sylvester, 1989). In the present study, teachers and children used storybook related manipulatives created by Lakeshore Learning Materials in the Storytime Counting Kits, Storytime Math Kits, and a Literature-Based Math Packet. The manipulatives included buttons, plastic fish, mice, cats, and dominoes (See methods section for a complete list of manipulatives).
3. Scaffolding – In a classic study by Wood, Bruner, and Ross (1976), scaffolding was defined as a process that enables a child or novice to solve a problem or achieve a goal which would be beyond his or her unassisted efforts. Essentially, the adult or more mature learner "controlled" the elements of the task that were initially beyond the learner's capacity. Scaffolding always started with verbal instruction to the child. The teacher intervened more directly if the child was unable to follow verbal instructions (Wood, Bruner, & Ross, 1976). The most basic level of scaffolding was

the general verbal instruction. For example, the teacher attempted to help the child toward a specified goal by saying, “What are you going to do next, count another piece?” A higher level of scaffolding included the teacher not only indicating to the child what material was necessary to complete the task, but also aiding the child in task completion. An example of this higher level of scaffolding would be for the teacher to count the objects with the child while holding the child’s finger as he or she pointed to each object. For example, the teacher might say, “Let’s count and point together, one, two, three…ten.”

4. Zone of Proximal Development (ZPD) – according to Vygotskian theory, the region of instruction and learning where children might not fully understand the concept at first but would understand with appropriate scaffolding by a more mature learner (Charlesworth, 1997). As Bodrova and Leong (1996) explained, development of a behavior occurred on two levels, which form the boundaries of the ZPD. The lower level was the child’s independent performance, and the higher level was the child’s maximum performance with assistance. Further, Bodrova and Leong remarked that Vygotsky was vague as to how the child reaches the upper limit of the zone. Consequently, researchers and psychologists have taken the idea of the zone of proximal development and tried to delineate more clearly what goes on within the zone. In a seminal work by Wood and Middleton (1975), the term “region of sensitivity” was used in place of the term “zone of proximal development.” The region of sensitivity was defined as that level at which the child fails to follow instructions and complete a task on his or her own. Furthermore, Wood and

Middleton hypothesized that the most effective instructors instruct within the region of sensitivity. Conner, Knight, and Cross (1997) stated that the effective teacher would find the ZPD, or region of sensitivity, and would direct the child forward from that level or component of the task. The child would then be able to accomplish the task and eventually internalize the procedure to move on to the next level until the goal was achieved.

Significance of the Study

Copley (1999) and Hong (1996) stated there is a surprising lack of empirical studies that investigate the effectiveness of using children's literature to teach mathematics in the early childhood classroom. Following their own study, Jennings, Jennings, Richey, and Dixon-Krauss (1992) recommended further research be conducted involving children's literature and mathematics achievement at different grade levels and across different socioeconomic groups. The present study adds to research on children's mathematics achievement in relation to children's literature by focusing on a sample of preschool-aged children. This study also contributes to current research on children's literature and mathematics instruction through the implementation of an instructional method in which teachers utilize children's literature, math manipulatives, and scaffolding with young children. To date, little is known empirically about the effectiveness of instructional practices, or teaching methods, utilized in bringing together children's literature and mathematics to foster mathematics achievement. The literature-mathematics-scaffolding (LMS) approach is unique and, therefore, important to the field of early childhood mathematics. Studying the LMS approach as an instructional method begins to answer a key question asked by Baroody (2000), “How should preschoolers be taught mathematics?”

The present study is also significant to the body of research on scaffolding. Although researchers initiated studies involving teacher scaffolding across various curriculum areas throughout the 1980s and 1990s (Brodova & Leong, 1996; Wollman-Bonilla & Werchadlo, 1999), a review of recent literature found no recent studies involving teacher scaffolding of mathematics at the preschool level. Therefore, through the involvement of preschool teachers in an intervention employing a scaffolding technique of young children’s mathematical thinking, this study furthers research on teacher scaffolding of young children’s learning.

Limitations of the Study

The findings of the study were limited by two factors. First, the study was conducted using a small sample of teachers (n =6) and preschool-aged children (n=60) in two child care centers in two neighboring southern cities, thus limiting the generalizability of the findings. Second, the teachers in the study were a sample who volunteered to participate in the investigation.

CHAPTER II

Review of Literature

The primary purpose of the present study was to determine if preschool children's mathematics test scores could be improved through the implementation of a three-part intervention involving teachers' use of children's literature, related storybook manipulatives and scaffolding (the LMS approach) to learning with preschool children. The following review of related literature is organized into four sections. The first section summarizes research highlighting the importance of mathematics for preschool children. The second section addresses findings from studies that investigate the connection between children's literature and mathematics achievement of early childhood students. The third section discusses research findings related to the use of mathematical manipulatives in the early childhood years. Finally, the fourth section addresses findings from studies that relate teachers' scaffolding to children's subsequent learning.

Mathematics and the Preschool Child

For almost 200 years, theorists and pedagogues have aligned with one of two major fluctuating views on appropriate mathematics experiences for young children (Balfanz, 1999). Balfanz described the two views as one based on considerable time observing children explore the world around them and the other as derived from global developmental and social theories not based on direct and sustained observation. The first view, based on child observation, included such educational icons as Froebel and

Montessori who advanced the notion that young children are capable of complex mathematical thought and enjoy using mathematics in natural exploration. The second view, based on social and global developmental theory, charged that, for one reason or another, it is harmful and inappropriate to introduce young children to mathematics in an organized fashion. Balfanz (1999) explained these two views alternated in influence from approximately 1820 to 1920. From 1920 until today, the social theorists' view on the limited relevance of early mathematics instruction became institutionalized with kindergarten in public schools and continues to shape educators' perceptions on the mathematics instruction of young children.

Early in the twentieth century young children were viewed as mathematically inept (Baroody, 2000). For example, Thorndike (1922) concluded that young children were so mathematically inept that they would gain little by doing arithmetic before grade 2. Millican (1994) described this old paradigm of mathematics instruction and learning as the notion that young children have a limited understanding of the nature of math. The old paradigm of mathematics instruction for young children challenged the importance of mathematics for the young child or student. Even Piaget (1965), who believed that children had a natural curiosity, thought that very young children were not capable of abstract concepts or logical thinking. Thus, Piaget concluded that preschool-aged children were not capable of a true understanding of arithmetic or the concept of number (Baroody, 2000).

However, a new vision of mathematics education recommends that educators involve children in a variety of mathematical experiences and teach children to use mathematics to solve everyday problems (Baroody, 2000). A statement in the discussion draft of the Principles and Standards for School Mathematics by the National Council of Teachers of Mathematics (1998) strongly asserted the importance of mathematics during the preschool years: "The foundation for children's mathematical development is established between infancy and kindergarten" (p. 1). Nunes and Bryant (1996) stated that although a child's mathematics career in a formal sense begins at school, it would be absurd to think that a child understands nothing about mathematics until a teacher educates him or her about it. Moreover, if one searches for the first genuine mathematics experiences in a child's life, one would need to return to the child's infancy to do so. Furthermore, in the last 20 years, research on children's knowledge and learning of mathematics has resulted in a significant reconceptualization of the nature of early mathematical knowledge, attributing much more mathematical knowledge and understanding to young children and specifically focusing on how young children acquire mathematical knowledge informally (Baroody, 2000; Copley, 1999; NCTM, 1998; Resnick, 1989). Berk (1999) emphasized that mathematical reasoning, like literacy, is built on young children's informal acquired knowledge. Throughout the 1990s, researchers have noted that if young children are to succeed in their study of mathematics, they must be allowed to examine, explore, and express the informal mathematical relationships they experience in everyday life (Baroody, 2000; Ginsburg & Baron, 1993).

Many believe the theoretical foundations of early childhood mathematics instruction in the twentieth century lie in the constructivist approach inspired by the work of Jean Piaget (Charlesworth, 1997; Cobb, 1994). The Piagetian constructivist view places the major focus on the child, the child's developmental maturation, and his or her spontaneous discoveries of the logico-mathematical nature of the physical environment (Charlesworth, 2000; Kamii, 1985). Historically, especially in the Piagetian tradition, research has focused on the limits of preschoolers' mathematical knowledge rather than on the nature and breadth of young children's mathematical knowledge and understanding (Gelman & Gallistel, 1978;Resnick, 1989). Kamii (1985) argued that the rate of a child's cognitive development limits the mathematical concepts that are at particular ages or grade levels. Long-standing Piagetian claims of limitations on children's numerical concepts continue to be challenged, particularly in relation to children's counting and forms of reasoning such as conservation and class (Gelman & Gallistel, 1978; Nunes & Bryant, 1996; Sophian & McCorgray, 1994). Even though evidence still persists related to young children's difficulties with numerical reasoning on different types of problems, Sophian and McCorgray (1994) have maintained that the cognitive developmental consideration of children's achievements and capabilities can inform effective instruction.

Piaget remains the pioneer of constructivist theory in the twentieth century especially in relation to mathematics; however, other theorists and their ideas are also significant to mathematics education for young children. For example, Dienes's theories focused on mathematics and highlighted the intrinsic value of mathematics to the learner (Dienes & Golding, 1971). Dienes's work, similar to Piaget's in several ways, highlighted the notion of active involvement based on concrete experiences (Shaw &

Blake, 1998). Furthermore, Montessori emphasized the prepared environment and formal mathematics instruction beginning at age 4. Finally, Vygotsky's theory placed importance on cognitive development as a socially mediated process involving scaffolding (Berk, 1999).

Based on various theoretical frameworks, much of the research on young children's understanding of mathematics prior to formal schooling has concentrated principally on children's acquisition of counting principles (Gelman & Gallistel, 1978; Graham, Nash, & Paul, 1997; Resnick, 1989). However, more recent mathematics education research includes a growing body of studies that focus on young children's development and learning (Baroody, 2000; Charlesworth, 1997). For example, Sophian and McCorgray (1994) investigated part-whole knowledge and early arithmetic problem solving in four- to six-year-old children. Mix, Levine, and Huttenlocher (1999) indicated that preschoolers understand simple fraction addition and subtraction. Also, Clements, Swaminathan, Hannibal, and Sarama (1999) studied three- to six-year-old children's concepts of shape, finding that children construct and attend to properties of geometric shapes which are aided by the use of manipulatives for physical construction tasks. Further, Clements et al. claimed that geometric levels of thinking coexist and that progress through such levels is determined more by social influences, specifically instruction, than by age-linked development. In 1995, the National Council of Teachers of Mathematics published a book titled, <u>Research Ideas for the Classroom: Early Childhood Mathematics</u>, which covered research topics from early number concepts to problem solving in early childhood, including the teaching of measurement, geometry, and spatial sense (Jensen, 1995).

Today, research supports the idea that even though children differ in their level of interest and ability in mathematics, children at any given developmental stage can learn to reason, formulate hypotheses, and problem-solve (Ward, 1995). Taylor (1995) urged that mathematics is not something that waits until a child enters a formal classroom at a prescribed age. Geary (1994) reported that depending on the extent to which informal counting experiences are available in children's everyday lives; children may acquire early number understanding at different rates. In preschools where adults provide many number activities, Geary maintained that children construct basic number concepts sooner. Ginsburg and Baron (1993) and Charlesworth (1997) presumed that young children have a natural curiosity regarding mathematical events and that they build up a storehouse of mathematical knowledge through numerous preschool experiences. Moreover, Harsh (1987) and Ward (1995) warned that even though teachers of young children recognize the value of children's literature, books are often overlooked as a basis for exploring mathematical concepts.

Children's Literature and Mathematics

Welchman-Tischler (1992) stated that children must find mathematical experiences interesting if they are to achieve their potential, and using children's literature is a springboard to capture the interest of young children and for investigating mathematical ideas (Whitin, Mills, O'Keefe, & Thiessen, 1994). Recognizing the value of literature in increasing children's early knowledge of mathematics or science is the first step toward integrating the curriculum with children's literature (Benson & Downing, 1999). Further, Benson and Downing characterized an integrated curriculum as one that encourages children to learn in a way that is natural to them and that is not simply a collection of meaningless fragments of information. Hong (1999) echoed the sentiments of Benson and Downing expressing that mathematics education should be integrated with other subject areas and should make use of natural connections wherever they occur.

Charlesworth (1997) emphasized that developmentally appropriate practices for teaching young children should include an integrated curriculum based on children's natural interests that allows for construction of concepts through exploration of concrete materials. Bredekamp and Copple (1997) expanded the discussion of developmentally appropriate practice and integrated curriculum by commenting that it is appropriate practice to use curriculum content from various disciplines such as math, science, or literature through themes, play, or other learning experiences. The NCTM acknowledged the integration of mathematics and reading (literature) in their publication the <u>1995 Yearbook: Connecting Mathematics across the Curriculum</u> (Balas, 1997; House, 1995). More directly addressing developmental appropriateness, the NCTM in 1991 published a position statement entitled <u>Early Childhood Mathematics Education</u> stating clearly, "The National Council of Teachers of Mathematics believes that early childhood mathematics education, for young children aged 3-8, should be developmentally appropriate" (p. 4).

Over the last decade, a great number of articles and books have described developmentally appropriate integration of children's literature and mathematics. Titles of such materials include How to Use Children's Literature to Teach Mathematics (Welchman-Tischler ,1992), Math through Children's Literature (Braddon, Hall, & Taylor, 1993), "Using Picture Books to Teach Mathematical Concepts" (McMath & King, 1994), Integrating Children's Literature and Mathematics in the Classroom (Schiro, 1997), and "Rejuvenate Math and Science – Revisit Children's Literature" (Benson & Downing, 1999). Shaw and Blake (1998) have maintained books are available to help educators select children's literature with mathematics connections and to suggest activities to complement stories in children's books. Two examples of such books are The Wonderful World of Mathematics (Theissen, Matthias, & Smith, 1998) and Read Any Good Math Books Lately? (Whiten & Wilde, 1992). The Wonderful World of Mathematics includes annotations of over 500 books for preschool and young school-age children. Each book is rated according to its usefulness in teaching mathematics concepts. In Read Any Good Math Books Lately?, the authors suggest many trade books, both fiction and nonfiction, that support various mathematical topics and provide examples of teachers using these books in integrated ways at various grade levels.

Like Whitin and Wilde (1992), many early childhood educators have argued that children's literature deserves a legitimate place in the mathematics classroom (Whitin, Mills, O'Keefe, & Thiessen, 1994). Four such reasons that children's literature deserves a prominent place in the mathematics classroom are a) literature furnishes a meaningful context for mathematics, b) literature celebrates mathematics as a language, c) literature integrates mathematics into current themes of study, and d) literature supports the art of problem posing (Whitin, Mills, O'Keefe, & Thiessen, 1994). Welchman-Tischler (1992) proclaimed new ways of using children's literature to teach mathematics are being proposed such as using literature to provide a context for an activity with mathematical content or introducing vocabulary associated with mathematical concepts.

Hong (1996,1999) has identified several theoretical bases for the use of children's literature in mathematics education. She has highlighted three of the main research bases as a) research on memory and knowledge representation, b) research on motivation, and c) research on the importance of meaningful context in establishing mathematical thinking. Hong's research on memory suggests that young children find it easier to organize their experiences according to scripts. Similarly, Seifert (1993) argued that young children learn more easily if a task is presented in a story format. Therefore, the use of children's literature can make mathematical concepts more relevant due to the narrative context. Hong drew implications from research on motivation to show that if a setting is related to a child's own experiences and if background knowledge is given, the child's motivation to pursue a related learning activity increases. Lastly, Hong stated that most educators emphasize the importance of meaningful context in relation to children's learning. Hong's research shows that storybooks provide a context that is interesting and meaningful to children.

Thiessen, Matthias, and Smith (1998) maintained in the past decade the use of children's literature in mathematics education was popularized. The evidence of this is found in the number of resources on how to use children's books in the classroom, the number of articles on children's literature in Teaching Children Mathematics, and the number of new children's books in mathematics. With the large number of books and articles written about the literature-mathematics connection, it is surprising that the number of recent empirical studies on the effectiveness of using children's literature in early childhood mathematics instruction is lacking (Copley, 1999; Hong, 1996). Furthermore, few researchers have tested the hypothesis that reading quality children's literature improves young children's mathematics achievement. A discussion of the two studies located within the decade of the 1990's that investigated the children's literature-mathematics connection follows. Both studies involved children of kindergarten age.

Jennings, Jennings, Richey, & Dixon-Krauss (1992) used children's literature to teach mathematics concepts to kindergarten children through webbing of mathematical concepts and activities. The researchers were interested in determining if the incorporation of children's literature into the mathematics curriculum would improve children's math achievement test scores and increase children's interest in mathematics. The children in the experimental group showed a significant increase over the control group on a test of mathematics ability. Jennings et al. recommended that further research be conducted involving children's literature and mathematics achievement at different grade levels and across different socioeconomic groups.

Building on the Jennings et al. (1992) study, Hong (1996) analyzed the effectiveness of using children's literature with kindergarten children in Korea to promote mathematics learning and children's dispositions toward doing mathematics. The main purpose of Hong's study was to confirm that teaching mathematics through children's literature improves children's dispositions toward mathematics. Throughout the study the experimental group of children chose more mathematics tasks than the control group and liked the mathematics corner more than any of the other learning corners provided. The researchers concluded that the disposition to voluntarily pursue mathematics learning could be increased through children's literature. However, in investigating the effects of using children's literature on mathematics achievement, the results of the standardized mathematics achievement test indicated that there were no differences in achievement between the experimental and control groups at the study's end. This was an unexpected result based on the Jennings et al. (1992) study with American kindergarten children. One possible reason given for the discrepancy between the Hong (1996) and the Jennings et al. study was that children's at home experiences might differ in the two cultures.

Mathematics Manipulatives

The recommended use of mathematics manipulatives with young children dates back over 180 years. In 1818, Goodrich's highly revolutionary book, The Children's Arithmetic, was one of the first books to propose that young children discover the rules of arithmetic through the manipulation of tangible objects like bead frames or counters (Balfanz, 1999). In the 1850's, Froebel created a pedagogy based on the use of geometric forms and the manipulation of symmetries. Balfanz describes Froebel's kindergarten as consisting of 21 "gifts" used in short sessions of directed play to create what he called nature, beauty, and knowledge forms. Froebel's gifts consisted of items such as a collection of six balls in the primary colors, increasingly complex sets of geometric blocks, and a cube, cylinder, and sphere. In the 1930's, mathematics research emphasized the development of understanding as fundamental in learning mathematics (Kennedy &

Tipps, 1994). Hiebert and Carpenter (1992) explained that individuals understand something if they see how it is connected or related to other things they know. Based on the belief that children must understand what they are learning if learning is to be permanent, Brownell's (1930) meaning theory supported the use of concrete objects or manipulatives in understanding new concepts and skills (Kennedy & Tipps, 1994; Sylvester, 1989). In the twentieth century, Dewey, Bruner, Montessori, Piaget, and Kamii also highlighted the importance of manipulative materials for successful mathematics learning to take place (McNeil, 1985; Sylvester, 1989). Montessori's prepared environment stresses the significance of an organized and coordinated set of materials to promote learning (Shaw & Blake, 1998).

In every decade since 1940 the National Council for Teachers of Mathematics has advocated for the use of concrete objects, referred to as manipulatives, as a means of introducing mathematical concepts and skills to children (Hartshorn & Boren, 1990; Sylvester, 1989). During the 1980's and 1990's, numerous articles appeared in Arithmetic Teacher, Mathematics Teacher, and various NCTM Yearbooks demonstrating the uses of manipulatives for young children (Sylvester, 1989; Zarra, 1999). Hong (1999) has maintained that stories involving objects that can be manipulated provide children with many meaningful ways of using manipulatives to explore mathematics concepts. Clements (1999) stressed that students who use manipulatives in their mathematics classes or activities usually outperform those students not using manipulative materials. Clements added that the benefit of manipulative use typically holds across grade level, ability level, and topic, given that the use of a manipulative makes sense for that topic or mathematics problem.

Most research on manipulatives and student achievement has taken place with children age five and older and has consistently supported the use of manipulative materials in all areas of mathematics (Kennedy & Tipps, 1994). In a review of mathematics learning from kindergarten to eighth grade, Suydam and Higgins (1977) determined that in using manipulatives mathematics achievement was increased. Furthermore, Sowell (1989) performed a meta-analysis on 60 studies examining the effectiveness of various types of manipulatives with kindergarten to college-age students. Sowell found that manipulatives could be effective. However, the studies reviewed by Sowell suggested that many teachers have not used manipulatives consistently. In 1999, Zarra compared the effectiveness of different storytelling strategies with and without manipulatives for preschool children with disabilities. The results of the study indicated that there was a significant increase in story recall for children when manipulatives were involved in storytelling.

Despite years of research focused on the positive use of manipulatives in the classroom, Baroody (1989) has maintained that work with manipulatives does not guarantee success. Grant, Peterson, and Shojgreen-Downer (1996) emphasized that teachers often use mathematics manipulatives without reflecting on use of the manipulatives in representing mathematical ideas to children. Futher, Clements (1999) added that students sometimes learn to use manipulatives in a rote manner, learning little more than steps in a process. Clements clearly stated that manipulatives alone are not sufficient for mathematics learning. Manipulatives "…must be used in the context of educational tasks to actively engage children's thinking with teacher guidance" (Clement, 1999, p. 56). Moreover, Heibert et al. (1996) discussed two points to keep in mind when using mathematics tools, or manipulatives, with children. First, meaning is not inherent in the tools themselves; students must construct meaning for the tools. Second, meaning developed for the tools is a result of children actively using the tools, not from adult demonstrations of tool use. In sum, most research on manipulatives and student achievement has supported the use of manipulative materials in all areas of mathematics. However, researchers encourage teachers to be mindful of the use of manipulatives in the classroom with young children.

Teachers' Scaffolding of Children's Learning

The work of Lev Vygotsky has become influential to mathematics teaching and learning with young children, especially in regard to teachers' scaffolding of children's learning (Charlesworth, 1997; Cobb, 1994). Wood, Bruner, and Ross (1976) defined scaffolding as a process that enables a child or novice to solve a problem or achieve a goal, which would otherwise be beyond his or her unassisted efforts. Essentially, the adult or more mature learner "controls" the elements of the task that are initially beyond the learner's capacity. Then, the task of the adult becomes one of timing the removal of the scaffold to enhance the child's successful independent performance (Bodrova & Leong, 1996). Bruner (1983) defined this shift in responsibility as the "hand-over principle" by which the child who was the spectator becomes a participant.

Bodrova and Leong (1996) and Dixon-Krauss (1996) have written books about the Vygotskian approach to teaching and learning including the scaffolding approach in the early childhood classroom. Other researchers have taken the Vygotskian notion of scaffolding and applied it to research studies involving parents and children (Conner, Knight, & Cross, 1997; Martin & Reutzel, 1996; Wood & Middleton, 1975) or teachers and children (Fleer, 1992; White & Manning, 1994; Wollman-Bonilla & Werchadlo, 1999). Many studies of parents' or teachers' scaffolding have shown positive effects of this method of informal instruction.

In 1975, Wood and Middleton conducted a study of assisted problem solving, or scaffolding, between 12 mothers and their preschool-aged children. The main interest in the study was the mother's level of intervention and the way in which she modified her intervention based on her child's responses, the mothers' scaffolding of her child's learning. The task involved a mother and her child constructing a nine-inch high six-level pyramid of 21 interlocking blocks. The researcher showed the mother how to construct the toy while the child played in another room. Then, the child joined the mother and the session started. The sessions were videotaped and analyzed after completion of the study. Wood and Middleton outlined five levels of intervention: general verbal instruction, specific verbal instruction, mother indicates material, mother provides material and prepares it for assembly, and mother demonstrates an operation.

In 1976, Wood, Bruner, and Ross utilized the same pyramid task with a group of 30 three-, four-, and five-year-old children and a researcher as tutor. The tutor would always instruct verbally first, before intervening more directly, only doing the latter when the child failed to follow a verbal instruction. The researcher videotaped the sessions. Every intervention by the tutor was noted and classified into one of three categories: direct assistance, verbal error prompt, and straightforward verbal instruction to the child. Also, the assembly operations by the child were categorized into assisted and unassisted actions. The researchers found that the younger the child, the more direct assistance the child needed. Furthermore, younger children ignored more of the tutor's interventions than older children. Several scaffolding functions were outlined in the analysis of tutoring in the study: recruitment (enlist interest of child), reduction in degrees of freedom (simplifying the task), direct maintenance (keeping in pursuit of goal), marking critical features, frustration control, and demonstration (modeling solutions).

Based on the studies by Wood and Middleton (1975) and Pratt, Kerig, Cowan and Cowan (1988), Conner, Knight, and Cross (1997) implemented a study with mothers' and fathers' scaffolding of their 2 year-olds during problem solving and literacy interactions. This study involved 32 intact Caucasian families. The researcher assessed mother-child and father-child dyads at least one week apart. Each session lasted approximately one hour and involved both problem-solving and literacy tasks. The problem-solving and literacy tasks consisted of two parts: a parent-child interaction and a child performance task. The researcher videotaped the sessions. Overall, the results showed that mothers and fathers utilized contingent or conditional dyadic behaviors during informal interactions with their young children. The study also provided evidence for effective parental scaffolding with children during the toddler years. Mothers and fathers were equally effective in their use of the region of sensitivity and appropriate shifting during the problem-solving tasks. In the literacy interactions, mothers appeared more comfortable balancing instruction with allowing the children to explore and initiate new behavior, while fathers appeared to be more focused on the goal of reading, resulting in more attempts to keep their children on-task.

During the 1990's, researchers initiated studies involving teacher scaffolding across various curriculum areas. Fleer (1992) studied the teacher-child interaction that scaffolds scientific thinking in 5- to 8-year-old children. White and Manning (1994) investigated the effects of verbal scaffolding instruction on young children's private speech and problem-solving capabilities in public school kindergarten. Most recently, Wollman-Bonilla and Werchadlo (1999) researched teacher and peer roles in scaffolding first graders' responses to literature. The researchers in each of these studies provided support for scaffolding the learning in the particular curricular area: science, problem solving, and literature.

In summary, this review of related literature was organized into four sections. The first section summarized research highlighting the importance of mathematics for preschool children. The second section addressed findings from studies that investigate the connection between children's literature and mathematics achievement of early childhood students. The third section discussed research findings related to the use of mathematics manipulatives in the early childhood years. Finally, the fourth section addressed findings from studies that relate teachers' scaffolding to children's subsequent learning.

In conclusion, the more recent mathematics education literature clearly denotes a growing body of studies that focus on young children's development and learning (Charlesworth, 1997). Furthermore, along with the attribution of more mathematical knowledge and understanding to young children, educators have become more interested in the classroom connections between children's literature and mathematics. Therefore, the present study adds to research on children's mathematics achievement in relation to children's literature by focusing on a sample of preschool-aged children.

CHAPTER III

Method

The primary purpose of the present study was to determine if children's mathematics test scores could be improved through the implementation of an intervention involving teachers' use of children's literature, related storybook manipulatives, and a scaffolding approach to learning with preschool children. Additionally, the literature-mathematics-scaffolding intervention was examined in relation to teachers' perceptions of their effectiveness in their math instruction.

Subjects

The subjects of the study included 60 preschool-aged (three-, four-, and five-year-olds) children and six teachers from two child care centers. Of the 60 prekindergarten children, 57% were male (n=34) and 43% were female (n=26). Forty-six percent of the children were three-year-olds, 33% were four-year-olds, and 20% were five-year-olds. The children in the study were predominately Caucasian (78%). Further, 12% of the children were Hispanic, 3% were African American, and another 3% were of other ethnic backgrounds. Table 1 presents the demographic characteristics of the children.

All of the teachers in the study were female. Four teachers were Caucasian, and the other two teachers were African American. Three of the teachers had taught preschool children for less than five years, while the other three teachers had taught preschool age children for over 10 years.

Two child care centers participated in the study. The first center was a private, academic-oriented program. The second center was an NAEYC accredited hospital-affiliated center. Four classrooms participated in the study, two from each center. The researcher randomly chose one classroom in each center to serve as a control classroom and the other as an experimental classroom.

Table 1

Demographic Characteristics of Preschool Children (N=60)

Characteristic	n	Percent
Age		
Three	28	46.7
Four	20	33.3
Five	12	20.0
Ethnicity		
Caucasian	47	78.3
Hispanic	7	11.7
African American	3	5.0
Other	3	5.0
Gender		
Male	34	56.7
Female	26	43.3

(table continues)

Characteristic	n	Percent
Control Group	30	100.0
Age		
Three	13	43.3
Four	12	40.0
Five	5	16.7
Ethnicity		
Caucasian	24	80.0
Hispanic	2	6.7
African American	2	6.7
Other	2	6.7
Gender		
Male	16	53.3
Female	14	46.7
Experimental Group	30	100.0
Age		
Three	15	50.0
Four	8	26.7
Five	7	23.3
Ethnicity		
Caucasian	23	76.7
Hispanic	5	16.7
African American	1	3.3
Other	1	3.3
Gender		
Male	18	60.0
Female	12	40.0

Procedures

The researcher targeted two centers for this study. The four main reasons for targeting these centers were that (a) they were fairly close in proximity to the researcher's university, and (b) the centers served preschool-age children and their families, (c) the center directors and teachers were willing to take part in the study having worked with the researcher on a previous project, and (d) the families were willing to take part in a study having participated in earlier research endeavors. Brief, one-page descriptions of the study and consent forms (see Appendix A) were delivered to each child care center. The directors and preschool teachers were asked to distribute these descriptions to parents of full-time three-, four-, and five-year-old children enrolled in their respective classrooms. The parents who were willing to have their children participate in the study completed the consent forms and returned the forms to their children's teachers. Of the 60 sets of parents who were given descriptions of the study and consent forms, all 60 returned their completed consent forms (100%). Data from 59 children were used to test for equivalency between groups in the study (98%), and data from 57 children whose parents gave written consent were used to test for posttest differences between groups (95%). The reason for missing child data was that parents took their children out of child care for the summer months, which was before the conclusion of the study.

The researcher called the centers to confirm that the consent forms had been returned and went to each center to pick up the forms. The researcher established rapport with the children and teachers in the classrooms. After spending two days in each classroom, the researcher began pre-testing the children using the Test of Early Mathematics Ability.

The researcher explained to the participating teachers the length of the project and the expectations of the teachers during the project. Participating teachers signed consent forms. Descriptions of what the project entailed differed depending on whether the teacher was in the control or experimental group. The researcher met with each teacher individually for an hour minimum to describe and train the teachers in the control or experimental method. For example, the experimental teachers were trained thoroughly on how to read children's books, how to discuss the math-related concepts from the book while using manipulatives as visual aids, and how to scaffold children's learning when the children explored the book and manipulatives during center time. Each experimental group teacher was provided daily scripts and lesson plans to follow for the books given (see Appendix B). Procedures were acted out with the teachers using an example book and manipulatives, and then each teacher performed the same procedure with the researcher.

The Literature-Mathematics-Scaffolding Approach

The three-part mathematics intervention involved experimental group teachers reading selected children's literature, using related storybook manipulatives, and implementing teachers' scaffolding techniques (LMS approach) with three-, four-, and five-year-old children. The researcher created the LMS approach based on a literature review of children's literature in relation to mathematics instruction, the concepts found in the Texas Pre-kindergarten Curriculum Guidelines for Mathematics, the use of mathematics manipulatives in early childhood, and teacher scaffolding. Following is a description of this model mathematics intervention.

Based on the use of children's literature as a springboard for mathematics learning, the LMS approach is a preschool mathematics intervention that lasts 10 weeks. The LMS approach contains 10 weekly lessons. The LMS lessons plans were literature-based, one book per week. Each week's plans were broken down into daily lesson plans for the teachers to follow and included both large and small group activities. Each lesson had one or two learning outcome(s) and a daily plan for teachers to follow to help the children achieve the outcome(s). The teacher read the same book to the children throughout the week during large group reading time. Wednesday through Friday of each week the teacher involved children in small group experiences during small group instruction or center time. The LMS approach took teachers a minimum of 2 hours per week instructing the children in large and small group settings.

Monday:	15 minutes reading in large group
Tuesday:	15 minutes reading in large group
Wednesday:	15 minutes reading in large group;
	15 minutes in small groups with manipulatives
Thursday:	15 minutes reading in large group;
	15 minutes in small groups with manipulatives
Friday:	15 minutes reading in large group;
	15 minutes in small groups with manipulatives

LMS Children's Books and Manipulatives

The materials used in the intervention were taken from three existing mathematics kits: the Storytime Counting Kits, Storytime Math Activity Kits, and Literature-Based Math Packets from Lakeshore Learning Materials. The complete set of the Storytime Counting Kits includes individual kits: Counting Mice Kit, Number Sense Kit, and the Counting Pairs Kit. The complete set of the Storytime Math Activity Kits includes six kits: Quilt Patterns Kit, Sorting Fish Kit, Shapes Kit, Measurement Kit, Domino Math

Kit, and the Button Box Kit. Each kit contains a children's book, related storybook manipulatives, and a teacher activity guide. The Literature-Based Math Packet chosen for inclusion in this study was created based on the book, The Doorbell Rang.

Storytime Counting Kits

1. Counting Mice Kit: includes the book Mouse Count by Ellen Stoll Walsh. Children practice one-to-one correspondence and addition with over 200 play gray mice, four plastic jars, and four laminated activity mats.
2. Number Sense Kit: includes the book So Many Cats by Beatrice Schenk De Regniers. Children practice counting from 1 to 12 and build number sense with 70 colored cat counters and four laminated activity mats.
3. Counting Pairs Kit: includes the book How Many Feet in The Bed? by Diane Johnston Hamm. Children learn to count by twos with over 50 matching pairs of colored shoe counters and four laminated activity mats.

Storytime Math Activity Kits

1. Quilt Patterns Kit: includes the book The Quilt by Ann Jonas. Children learn patterning and ordering with 168 vinyl quilt squares in six patterns and four laminated activity mats.
2. Sorting Fish Kit: includes the book Fish Eyes by Lois Ehlert. Children practice counting with 126 play fish and four laminated activity mats.
3. Shapes Kit: includes the book Sea Shapes by Suse MacDonald. Children sort and classify shapes with 100 foam pieces and four laminated activity mats. The shapes include squares, circles, triangles, rectangles, ovals, diamonds, hearts, stars, etc.

4. Measurement Kit: includes the book Inch by Inch by Leo Lionni. Children practice measuring, estimating, and sorting with 48 snap together inch worms and four laminated activity mats.
5. Domino Math Kit: includes the book Domino Addition by Lynette Long. Children practice matching and basic addition with 4 sets of 28 dominoes (1 set of each color: red, blue, green, and yellow) and four laminated activity mats.
6. Button Box Kit: includes the book The Button Box by Margarette S. Reid. Children sort and classify buttons. The kit includes an assortment of different sized and colored buttons and four laminated activity mats.

Literature-Based Math Packet

1. This kit includes the book The Doorbell Rang by Pat Hutchins. Children practice counting with a set of 12 chocolate chip cookie manipulatives and four placemats.

The researcher chose to use the Lakeshore mathematics kits in the intervention for three main reasons. First, the books covered the concepts found in the Texas Pre-kindergarten Curriculum Guidelines for Mathematics: Number and operations, Patterns, Geometry and Spatial Sense, Measurement, and Classification and Data Collection (Prekindergarten Curriculum Guidelines, 2000). Second, the kits contained both children's books and storybook related manipulative materials. Third, a panel of early childhood teacher experts rated the materials as appropriate for the age group based on both literary and mathematical standards. Specifically, the researcher enlisted a panel of three early childhood teacher experts with minimum of five years of preschool teaching experience to rate each children's book on the Mathematical Trade Book Evaluation

(Schiro,1997). The teacher experts rated each book on a five-point Likert-type scale for both mathematical and literary standards. The ratings of each book are reported in Chapter 4 of the present study.

Scaffolding in the LMS Approach

The teachers' scaffolding techniques utilized in the study were based on the techniques used in previous teacher and parent scaffolding studies (Conner, Knight, & Cross, 1997; Pratt, Kerig, Cowan, & Cowan, 1988; Wood & Middleton, 1975). The researcher instructed the teachers on the scaffolding procedure and provided a written outline of the scaffolding procedure to each teacher. The scaffolding procedure included six well defined scaffolding techniques: enlisting the child's interest, observing the child's zone of proximal development (ZPD), simplifying the activity, providing verbal instruction, marking critical features of the task, and modeling solutions to the problem (See Appendix C). The researcher directed the teacher to always instruct a child verbally first, before intervening more directly, and only doing the latter when the child failed to follow a verbal instruction. An example of a scaffolding script for an activity based on the book Mouse Count is as follows (for the complete lesson plan including the scaffolding script see Appendix B):

1. Depending on the child's ZPD you already observed, choose the appropriate learning outcome, or task, for the child to attempt to achieve alone, scaffold the child's attempts to reach the goal as needed. For example, if the child is unable to get the mice out of the jar on his or her own and line the mice up to count them, simplify the activity for the child by placing ten mice in a row for the child to count.

2. If the child is not able to reach the learning outcome because he or she is counting each mouse more than one time, use a verbal instruction and say, “Please count each mouse only one time”.
3. Scaffold the child toward the main goal through verbal directions first. Then, if the child is not able to follow your directions, say, “Let me help you point to and count the mice. Let’s do it together”.
4. Finally, if the child is not able to do the activity along with you, have the child observe you modeling or demonstrating the activity for him or her (S6). Then, have the child attempt the activity with you again.

While the teachers in the experimental group followed a prescribed intervention plan based on the LMS approach, the teachers in the control group were given the same child learning outcomes as the experimental group (See Appendix D). Using the specific learning outcomes provided, the teachers in the control group taught the children in their classrooms using regular preschool teaching methods in large and small group settings. However, the time the control group teachers spent reading to children in a large group setting and working with children in small groups was strictly defined to match the time the experimental group teachers spent on similar tasks following the LMS approach. Prescribing equal amounts of time for specific learning activities in the classroom for the experimental and control groups added validity to the study and negated the issue of differing group outcomes due to the experimental group getting more time in direct learning with the teacher than the control group.

Theoretical Foundation

The work of Lev Vygotsky is influential to mathematics teaching and learning with young children (Charlesworth, 1997; Cobb, 1994) and serves as the foundation of the present study. A basic premise of Vygotsky's sociocultural theory is that all uniquely human, higher forms of mental functioning are jointly constructed and transferred to children through dialogues with other people (Berk, 1994). Vygotsky's theory placed importance on cognitive development as a socially mediated process involving scaffolding (Berk, 1999). Even though Vygotsky recognized the importance of developmental factors, he emphasized the importance of environmental and social factors in teaching and learning.

Vygotsky's explanation that good teaching is presenting material a little ahead of development suggests that learning precedes development (Vygotsky, 1962). The notion that learning precedes development is a hallmark of Vygotskian theory, with most other constructivists following the Piagetian idea that the pace of cognitive development limits the concepts that young children can learn and therefore should limit the level of teacher instruction (Baroody, 2000). Teachers following the Vygotskian approach scaffold children's instruction by identifying the zone of proximal development (ZPD) of each child.

The ZPD is one of Vygotsky's most well known concepts and is a way of conceptualizing the relationship between learning and development (Bodrova and Leong,1996). The ZPD refers to a range of tasks that the child cannot yet accomplish alone but can complete with the help of an adult or more skilled peer (Berk, 1994).

Bodrova and Leong (1996) explained that, for Vygotsky, development of a behavior occurs on two levels, which form the boundaries of the ZPD. The lower level is the child's independent performance and the higher level is the child's maximum performance with assistance. The present study highlights Vygotsky's notion of the ZPD. As Vygotsky was vague about exactly how the child reaches the upper level of the ZPD (Bodrova and Leong, 1996), the present study focuses on a scaffolding approach within the ZPD (see Chapter 1 for the definition of scaffolding).

Research Design and Data Analyses

The present study was an intervention project built on a quasi-experimental research design using pre- and post-tests of young children's mathematics achievement. Furthermore, the study could also be referred to as aptitude-treatment interaction research study (ATI research). Gall, Borg, and Gall (1996) defined ATI research as research designed to determine whether the effects of different instructional methods are influenced by cognitive or personality characteristics of learners. The researcher used the Test of Early Mathematics Ability and the Stanford-Binet Intelligence Scale as screening measures for group equivalence prior to the collection of TEMA posttest data. If group comparisons across the TEMA and the Stanford-Binet scores were statistically significant, it was predetermined that the researcher would use TEMA residual gain scores for group comparisons at the end of the study. Conversely, if the pre-test data comparisons were not statistically significant, this would serve as evidence of equivalence between the groups, and the quasi-experimental study would continue with unadjusted posttest TEMA scores serving as the dependent variable. The researcher used analysis of variance to analyze the data related to the first research question, Is there a difference in the Test of Early Mathematics Ability (TEMA) total posttest scores between children in the literature-manipulatives-scaffolding (LMS) intervention group and children in the control group after assuring equivalency of the two groups on the TEMA pretest and IQ variables prior to the collection of TEMA posttest data? The dependent variable was the total score of the TEMA. Lastly, the researcher utilized content analysis of descriptive data collected through semi-structured teacher interviews to answer the second research question, Do preschool teachers believe they are more effective in their mathematics instruction after implementing the LMS approach with young children?

Description of Measures

In addition to demographic information obtained from teachers' student records, the data for the present study came from pre- and post-tests of young children's mathematical ability using the Test of Early Mathematics Ability, Second Edition (Ginsburg & Baroody, 1990). Also, the researcher utilized the Stanford-Binet Intelligence Scale (Thorndike, Hagen, & Sattler, 1986) as an overall measure of general intelligence or reasoning ability of the preschool children. Furthermore, the researcher obtained teacher data through semi-structured 30-minute teacher interviews.

Demographic Information

The researcher collected demographic information on each child. Teachers completed a questionnaire giving limited demographic information on each participating child, including items related to the child's birth date and ethnicity (See Appendix E).

Semi-structured Teacher Interviews

The researcher interviewed participating control and experimental group teachers after the study on their beliefs about young children's abilities to learn mathematics in the classroom. The teachers answered questions such as, "Do you believe that children in your classroom can learn mathematics concepts through storybook reading?" The researcher asked similar questions of the control and experimental group teachers about their effectiveness in math instruction related to students' learning (See Appendix F). The 30-minute semi-structured interviews were recorded and transcribed yielding descriptive data. Gall, Borg, and Gall (1996) described the semi-structured interview as a series of structured questions asked by the interviewer followed by more open-form questions to obtain additional information. Using a semi-structured approach to interviewing, the researcher utilized a straightforward approach to analyzing the data through content analysis. According to Gall, Borg, and Gall (1996), content analysis is a research technique that can be used to analyze and objectively, systematically, and quantitatively describe audiotape recordings. The researcher in the present study developed a category-coding procedure and utilized frequency counts in interpreting the results of the semi-structured interview data.

Test of Early Mathematics Ability: Second Edition (TEMA-2)

The researcher used the Test of Early Mathematics Ability: Second Edition (Ginsburg & Baroody,1990) as a pre-and post-test measure of math performance and achievement of preschool-aged children. The TEMA-2 is a norm-referenced test that measures both formal and informal concepts and skills. The test is administered individually in approximately 15-20 minutes and measures the following domains: concepts of relative magnitude, reading and writing numerals, counting skills, calculation, number facts, calculational algorithms, and base-ten concepts.

TEMA-2 scores have been validated based on data from children ages 3 to 8 and are used to identify children who are significantly ahead or behind their peers in mathematical thinking. The normative sample was composed of 896 children representing 27 states and the characteristics of the sample approximate those in the 1985 U.S. census (Pro-Ed, 1999). Therefore, on the whole, the normative sample was a nationally representative sample (Ginsburg & Baroody, 1990).

Ginsburg and Baroody (1990) examined the TEMA-2 score reliability, the consistency with which scores measure an ability, using three procedures: (a) internal consistency, (b) alternate forms, and (c) standard error of measurement. First, the internal consistency for the TEMA-2 scores was reported for each age level. The internal consistency for three-year-olds' scores was .95; the internal consistency for four-year-olds' scores was .94; the internal consistency for five-year-olds' scores was .94. Second, the correlation of scores on the TEMA-2 with scores on the original TEMA was studied using 71 four- and five-year-old children in Austin, Texas. The TEMA and TEMA-2 scores correlated highly, providing evidence that the original TEMA scores are similar to scores from the TEMA-2. The children were all given the TEMA twice with one week between testings. Researchers used a partial correlation procedure to account for effects of age, and the resulting test-retest reliability coefficient was .94. Finally, the standard errors of measurement using data from 3-year-olds and 4-5 year-olds were 3 and 4 respectively.

Ginsburg and Baroody (1990) addressed three interrelated types of validity, the degree to which scores from a test measure what the authors say they measure, for TEMA-2 scores: content, criterion-related, and construct. First, Ginsburg and Baroody established content validity by using systematic and controlled item selection and analysis during test construction. Three kinds of items were used to measure children's informal mathematics competencies: (a) concepts of relative magnitude, (b) counting skills, and (c) calculational skills. Further, four kinds of items were used to measure children's formal mathematics competencies: (a) knowledge of convention, (b) number facts, (c) calculation, and (d) base-ten concepts. Second, criterion-related validity of the original TEMA scores was studied by correlating the scores with the scores on Math Calculation subtest of the Diagnostic Achievement Battery. The subjects used were 23 six-year-old and 17 eight-year-old students in Texas. The resulting coefficients were .40 and .59, respectively. Finally, Ginsburg and Baroody (1990) investigated the construct validity, the degree to which the traits underlying a set of test scores can be identified and the extent to which these traits reflect the theoretical model on which the test is based.

<u>Stanford Binet Intelligence Scale (SB:FE)</u>

The researcher used the Stanford Binet Intelligence Scale: Fourth Edition (Thorndike, Hagen, & Sattler, 1986) to measure the general intelligence, or reasoning ability, of the preschool-aged children in the present study and to assure equivalency of the experimental and control groups of children on IQ variables prior to collecting posttest TEMA data. The Stanford-Binet was the first American test to use the concept of the intelligence quotient (IQ) (Laurent, Swerdlik, & Ryburn , 1992). It is one of the most widely used measures of intelligence (Bass, 1990). The complete battery of the SB:FE consists of 8 to 15 tests, depending on the chronological age of the examinee and the examinee's established entry level. The scale yields five scores total. It consists of four content area, or broad, scores across the tests: Verbal Reasoning, Abstract/Visual Reasoning, Quantitative Reasoning, and Short-Term Memory. The fifth score is the composite score, g, of general reasoning ability.

In the present study, the researcher used an abbreviated screening battery of the SB:FE. The abbreviated scale included six subscales of the total battery yielding an accurate estimate of overall cognitive abilities: Vocabulary, Bead Memory, Quantitative, Memory for Sentences, Pattern Analysis, and Comprehension.

Hagen, Delaney, and Hopkins (1987) described the stratified standardization sample as consisting of over 5,000 persons between the ages of 2 and 23 years, tested in 47 states and the District of Columbia. K-R 20 reliabilities were found for each 1-year age group in the standardization sample for ages 2 to 17, and for the 18-23 year group. Reliabilities of the composite score ranged from .95 to .99, and for the separate tests, most reliabilities were in the .80s and low .90s (Hagen, Delaney, & Hopkins, 1987). Moreover, the test-retest reliability was determined by testing two groups after a two to eight month interval. One group of 57 children had a mean age of five years, two months. The other, older group had a mean age of eight years, one month. In the younger group, the test-retest reliability coefficient for the composite IQ score was .91 (Thorndike, Hagen, & Sattler, 1986).

Laurent, Swerdlik, and Ryburn (1992) state that the development of the SB:FE was guided by Horn and Cattell's (1966) hierarchical model of cognitive abilities. More specifically, the hierarchical model on which the SB:FE was based consists of a general reasoning factor, g, at the top level; three broad factors at the second level (i.e., Crystallized Abilities, Fluid-Analytic Abilities, Short-term Memory); and a third level of more specific factors (i.e., Verbal Reasoning, Quantitative Reasoning, Abstract/Visual Reasoning). Therefore, if factors corresponding to Verbal Reasoning, Quantitative Reasoning, Abstract/Visual Reasoning, and Short-Term Memory were found as a result of factor analysis, the theoretical model underlying the SB:FE would be supported.

Laurent, Swerdlik, and Ryburn (1992) studied factor-analytic studies measuring the construct validity of the SB:FE scores and found factor-analytic evidence in support of the SB:FE was mixed. However, each of the factor-analytic studies supported the notion of the SB:FE as a measure of a general factor of intelligence, g. Furthermore, in reviewing studies related to the criterion-related validity of the SB:FE, Laurent et al. (1992) stated that half of the validity coefficients reported equaled or exceeded .70, suggesting fair to very good consonance among the SB:FE and other existing measures of intelligence. Interestingly, most of the studies using an abbreviated battery of the SB:FE found similar results to those using the complete SB:FE. Laurent et al. (1992) maintained that this finding suggests that scores on the abbreviated batteries of the SB:FE are as valid a measure of the intellectual ability as the complete SB:FE.

CHAPTER IV

Results

The focus of the present study was the investigation of children's mathematics learning and achievement through the LMS approach. The primary purpose of the present study was to determine if children's mathematics test scores could be improved through the implementation of an intervention involving teachers' use of children's literature, related storybook manipulatives and a scaffolding approach to learning with preschool children. Additionally, the researcher investigated the literature-mathematics-scaffolding intervention in relation to teachers' perceptions of their effectiveness in mathematics instruction.

To address these research questions, six teachers and 60 preschool children between the ages of 3 and 5 years participated in the study. The teachers participated in either a control or experimental condition (the LMS approach) in their daily mathematics instruction with their preschool children. The teachers also participated in a 30-minute interview at the end of the study. The researcher tested the children using the Test of Early Mathematics Ability (TEMA) and an abbreviated version of the Stanford-Binet Intelligence Scale.

The results of the present study are provided in six main sections. The first section describes the findings related to the expert teacher ratings of the children's books used in the study. The second section presents the descriptive data for selected variables. The third section includes the data comparisons related to the equivalency of the two groups on the TEMA pretest and IQ variables prior to the collection of TEMA posttest data. The fourth section addresses findings related to the assessment of participants' mathematics test scores following the instructional intervention. The fifth section presents findings related to preschool teachers' perceptions of their effectiveness in mathematics instruction. Finally, the last section summarizes the overall findings of the present study. The researcher used the Statistical Package for the Social Sciences (SPSS) for Windows, Version 10 to maintain and analyze the quantitative data in the present study.

Ratings of Children's Books

The researcher enlisted a panel of three early childhood teacher experts with a minimum of five years of preschool teaching experience to rate children's books using Mathematical Trade Book Evaluation (Schiro, 1997). The teacher experts rated each book on a five-point Likert-type scale (5 = superb, 3 = average, 1 = worthless) for both mathematical and literary standards. All three teachers rated The Button Box (Reid, 1990) the highest on both the mathematical and literary standards. Further, the teachers rated The Quilt (Jonas, 1994) near average on both the mathematical and literary standards. Overall, the teachers rated the children's books higher on the mathematical standards than on the literary standards as addressed in the evaluation. Further, all three teachers commented to the researcher that they were familiar with and had used several of the books in the present study with young children. The average ratings of each book on mathematical and literary standards are shown in Table 2.

Thiessen, Matthias, and Smith (1998) rated 8 of the 10 books used in the present study on a 3-point Likert-type scale in their book, The Wonderful World of Mathematics.

The books rated were The Button Box (Reid, 1990), So Many Cats! (de Regniers, 1988), Fish Eyes: A Book You Can Count On. (Ehlert, 1990), Mouse Count (Walsh, 1991), How Many Feet in the Bed? (Hamm, 1994), The Doorbell Rang (Hutchins, 1986), Domino Addition (Long, 1996), and Sea Shapes (MacDonald, 1994). Each book was rated according to its usefulness in teaching mathematics. The Likert-type scale consisted of star ratings, three stars meant the book was “highly recommended”, two stars meant the book was “recommended”, and one star meant that the book was “acceptable.” None of the eight books were rated as highly recommended. However, five of the eight books were recommended: The Button Box, So Many Cats!, Mouse Count, How Many Feet in the Bed? and The Doorbell Rang. Moreover, the other three books used in the study were rated as acceptable for use in teaching mathematics: Fish Eyes: A Book You Can Count On, Domino Addition, and Sea Shapes.

Table 2

Teacher Mean Ratings of Children’s Books on Mathematical and Literary Standards

Book Title	Literary M	Mathematical M
Mouse Count	4.0	4.7
So Many Cats	3.3	4.3
How Many Feet in The Bed?	3.0	4.0
The Quilt	3.3	2.7
Fish Eyes	4.0	4.7
Sea Shapes	3.0	4.0

(table continues)

Book Title	Literary M	Mathematical M
Inch by Inch	4.7	4.3
Domino Addition	3.7	5.0
The Button Box	5.0	5.0
The Doorbell Rang	4.0	4.0

*Note: Mean ratings are based on Mathematical Trade Book Evaluation scores from three experts.

Descriptive Data on Selected Variables

Sample sizes, means, standard deviations, and standard errors for selected variables, Pretest TEMA, IQ, and Posttest TEMA are shown in Table 3. Experimental and control group means differed only marginally. Likewise, the posttest TEMA scores were very similar for the full sample and for two “spilt file” subsamples randomly selected for purposes of cross-validating the study’s results.

Table 3

Descriptives for Selected Variables

Source	n	M	SD	SE
Pretest TEMA				
Experimental	29	9.10	6.47	1.20
Control	30	11.63	8.47	1.55
IQ				
Experimental	29	103.97	11.08	2.06
Control	30	100.57	11.76	2.15
Posttest TEMA				
Experimental	27	12.96	7.66	1.47
Control	30	13.57	8.66	1.58
Split File TEMA				
1 Experimental	13	11.92	7.40	2.05
Control	16	14.69	10.18	2.54
2 Experimental	14	13.93	8.05	2.15
Control	14	12.29	6.67	1.78

Test for Equivalent Groups

Pursuant to addressing the study's first research question which queried the difference between the posttest TEMA means of experimental and control groups, the researcher first tested for the equivalency of the two study groups on the TEMA pretest and composite IQ variables prior to the collection of TEMA posttest data. The test for homogeneity of variance reported the Levene F statistic for the pretest TEMA was .164, $p > .05$, while the Levene F statistic for the composite IQ was .124, $p > .05$. Hence, the assumption of homogeneity of variance was met in both ANOVA analyses. The researcher used one-way analysis of variance (ANOVA) for the selected pretest variables: the pretest TEMA and the composite IQ. The differences between groups on the pretest TEMA (F (1, 57) = 1.655, $p > .05$), and composite IQ, (F (1, 57) = 1.304, $p > .05$), were negligible and not statistically significant.

Second, prior to running the present study's substantive data analysis, it was important to determine whether student achievement gains were contaminated by variability in child aptitude, IQ. To test for the relationship between child aptitude and achievement gain, participants were split into two groups based on the median split of IQ scores (Md = 106). These data were subjected to a one-way analysis of variance. The differences between groups on dichotomized IQ (F (1, 54) = .830, $p > .05$) were not statistically significant. These statistically nonsignificant results indicated that individual child variability in IQ was not a major determinant of differences in achievement gains, lending credibility to the appropriateness of attributing any gains that might be found to differences in the independent variable.

After testing for the equivalency of the two study groups and individual variability in IQ, the researcher determined the groups to be equivalent and continued the analyses using unadjusted posttest TEMA scores as the dependent variables. The results of the two pretest ANOVAs are presented in Table 4.

Table 4

One-way ANOVA for the Pretest TEMA and Composite IQ

Source	SS	df	MS	F	Sig.	Eta^2
Pretest TEMA	94.378	1	94.378	1.655	.203*	.028
Between Groups	249.656	57	57.012			
Within Groups	3344.034	58				
Total						
Composite IQ						
Between Groups	170.346	1	170.346	1.304	.258*	.022
Within Group	7448.332	57	130.672			
Total	7618.678	58				

* $p > .05$

Improvement of Children's Mathematics Test Scores

The researcher used one-way ANOVA to address the first research question, Is there a difference in the Test of Early Mathematics Ability (TEMA) total posttest scores between children in the literature-manipulatives-scaffolding (LMS) intervention group and children in the control group after assuring equivalency of the two groups on the TEMA pretest and IQ variables prior to the collection of TEMA posttest data? The test for homogeneity of variance reported the Levene F statistic for the posttest TEMA yielded satisfactory results ($F = .094$, $p > .05$). The difference between groups on the posttest TEMA, ($F(1, 55) = .077$, $p > .05$), was not statistically significant. Moreover the ANOVA effect size was negligible, indicating only about one-tenth of 1% relationship between the grouping and dependent variables ($eta^2 = .0014$). The results of the ANOVA for the posttest TEMA data are presented in Table 5.

Table 5

One-way ANOVA for the Posttest TEMA

Source	SS	df	MS	F	Sig.	Eta^2
Posttest TEMA						
Between Groups	5.179	1	5.179	.077	.783*	.001
Within Groups	3702.330	55	67.315			
Total	3707.509	56				

*$p > .05$

After finding no statistically significant difference between the experimental and control groups in posttest TEMA scores, the researcher used a cross validation analysis to investigate if any outlying scores might have skewed the results of ANOVA used for the posttest TEMA scores. For purposes of this analysis, the 57 posttest participants were randomly split into two subsamples of 29 (subsample 1) and 28 (subsample 2) participants. Descriptive data for experimental and control groups across the two subsamples are presented in Table 3. The ANOVA test for homogeneity of variance yielded a Levene F statistic for the TEMA subsample 1 of .395, ($p > .05$), while the Levene F statistic for the TEMA subsample 2 was .435, ($p > .05$) yielding evidence substantiating the appropriateness of using ANOVA. The ANOVA results indicated there was no statistically significant difference between groups on the posttest TEMA for either data subsample. The difference between groups on the posttest TEMA subsample 1 produced an F (1, 27) of .670, ($p > .05$), and subsample 2 data produced an F (1, 26) of .345, ($p > .05$). The results of this ANOVA - Cross Validation Analysis are presented in Table 6.

Table 6

<u>One-way ANOVA -TEMA Cross Validation Analysis</u>

Subsample	SS	df	MS	F	Sig.	Eta^2
Posttest TEMA 1	54.812	1	54.812	.670	.420*	.024
Between Groups	2210.361	27	81.865			
Within Groups	2265.172	28				
Total						
Posttest TEMA 2						
Between Groups	18.893	1	18.893	.345	.562*	.013
Within Groups	1421.786	26	54.684			
Total	1440.679	27				

*p>.05

The effect sizes (eta^2) for the two cross validation analyses were only about 1-2%. The power was .06 indicating a high probability of a Type II error. However, the researcher in the present study determined that Type II error is not likely through the examination of small mean differences and through the use of cross validation analysis. Hence, the answer to research question one is that there is no statistically significant difference in the Test of Early Mathematics Ability (TEMA) total posttest scores between children in the literature-manipulatives-scaffolding (LMS) intervention group and children in the control group.

<u>Teachers' Perceptions of Effectiveness in Mathematics Instruction</u>

The researcher used content analysis of semi-structured teacher interviews to address the second research question, Do preschool teachers believe they are more effective in their mathematics instruction after implementing the LMS approach with young children? More specifically, the researcher developed a simple category-coding procedure in interpreting the results of the semi-structured interview data. Gathered from the six teachers participating in the present study, the data yielded four categories related to the second research question. The categories included teachers' beliefs related to the following topics: 1) their ability to teach mathematics, 2) the use of goals in determining what mathematics skills are important for preschool children, 3) children's gaining skills in mathematics, and 4) children's lack of mathematics growth.

Teacher Effectiveness in Mathematics Instruction

All six of the teachers participating in the study (100%) reported that they were more effective in their mathematics instruction after participating in the study. The three teachers in the control group believed the study was important in enhancing their mathematics instruction through the focused goals given to them at the beginning of the study. Moreover, the three teachers in the experimental group believed the LMS approach improved their mathematics instruction with preschool children. One teacher from the experimental group stated, " I do believe that it (the LMS approach) has helped me become a better preschool teacher in using the math skills because using this material shows us how to put it together and use it to the child's advantage". Another experimental group teacher explained, "Math is a subject that most teachers are scared of, and when you look at it like this, we are dealing with math everyday, but doing this program reinforces what we are doing. It helped in a positive way".

What Mathematics Skills are Important for Preschool Children

Not only did the teachers believe that they were more effective in their mathematics instruction after participating in the study, but the six teachers also believed the goals given to them at the beginning of the study were helpful in determining what mathematics skills are important for preschool children. One of the teachers in experimental group explained that the LMS approach helped guide her mathematics instruction. She remarked, “Yes, having it there was better. It’s better to have something you read and say ‘ok’ that’s how I need to work on this…than it is to try to create it yourself”. A teacher in the control group stated she believed that the goals helped her know what children should be learning in the preschool years. She said, “Yes, I hadn’t really thought about them (children) having to know about the concept of zero and things like that…but that helped me because it gave me a set idea of what they are supposed to be learning”.

Children Gaining Skills in Mathematics

Just as all six teachers believed they were better preschool mathematics teachers after participating in the study, they all believed that the children in their respective classrooms had gained mathematics skills over the ten-week study. Each teacher was asked simply and directly, “Do you believe that the children in your classroom gained skills in mathematics over the ten-week study?” The teachers’ answers began in a similar way with: “Yes, very much so”, “Definitely”, “I do”, “Yes, I do”, “Definitely”, and “Some did! Some did!” One of the teachers in the experimental group expounded by saying, “Because for one thing, we made sure it was not just at random. We knew that everyday they were going to be going through this. And so we saw some results.”

Children’s Lack of Mathematics Growth

The researcher asked each teacher to think about and describe one child who lacked mathematics growth over the ten-week study. Four of the six teachers were able to discuss one child in their classroom who did not show mathematics growth during the study. Interestingly, all four teachers attributed the child’s lack of mathematics growth to either the child’s lack of interest or lack of the ability to attend to the activity. One of the teachers in the experimental group said, “ He didn’t have an interest in doing it. He had to be in the mood. He might come over and do it, or he might not. He just showed a lack of interest.”

Summary of Study Results

The researcher in the present study asked two main questions. First, Is there a difference in the Test of Early Mathematics Ability (TEMA) total posttest scores between children in the literature-manipulatives-scaffolding (LMS) intervention group and children in the control group after assuring equivalency of the two groups on the TEMA pretest and IQ variables prior to the collection of TEMA posttest data? Second, Do preschool teachers believe they are more effective in their mathematics instruction after implementing the LMS approach with young children?

The answer to the first research question is that there was no statistically significant difference in the Test of Early Mathematics Ability (TEMA) total posttest scores between children in the literature-manipulatives-scaffolding (LMS) intervention group and children in the control group. However, the answer to the second research question is that preschool teachers believed they were more effective in their mathematics instruction after implementing the LMS approach with young children. Furthermore, the teachers believed the children in their respective classrooms had gained mathematics skills.

CHAPTER V

Discussion

The focus of the present study was children's mathematics learning and achievement through the LMS approach. The primary purpose of the study was to determine if children's mathematics test scores could be improved through the implementation of an intervention involving teachers' use of children's literature, related storybook manipulatives and a scaffolding approach to mathematics learning with preschool children. This study examined two research questions. The first question asked if there was a difference in the Test of Early Mathematics Ability (TEMA) total posttest scores between children in the literature-manipulatives-scaffolding (LMS) intervention group and children in the control group after assuring equivalency of the two groups on the TEMA pretest and IQ variables prior to the collection of TEMA posttest data. The second question addressed if preschool teachers believed they were more effective in their math instruction following their participation in a literature-mathematics-scaffolding intervention? In order to address these research questions, the researcher collected data from six teachers and 60 preschool-aged children (3-5 years of age) enrolled in two child care centers.

The first section of this chapter discusses the findings of this study and provides a critique of the research. The second section addresses implications for preschool mathematics practice. The final section specifies recommendations for future research.

Findings and Critique of Research

The primary purpose of the study was to determine if children's mathematics test scores could be improved through the implementation of an intervention involving teachers' use of children's literature, related storybook manipulatives and a scaffolding approach to mathematics learning with preschool children. This study examined two research questions. The first research question asked if there were differences in posttest scores between children in the literature-manipulatives-scaffolding (LMS) intervention group and children in the control group. The results of the analysis of variance were not statistically significant, and thus did not affirm the hypothesis in this research question. Finding no significant differences between the LMS approach and goal-oriented, regular preschool teaching methods indicates that the LMS approach is as effective an approach to mathematics learning with preschool children as other goal-oriented approaches.

The findings of the present study add to previous research in the area of children's literature and mathematics. The findings are inconsistent with Jennings, Jennings, Richey, and Dixon-Krauss's study (1992) in which children's literature was incorporated into the mathematics curriculum and improved children's math achievement test scores. However, the findings of the present study were consistent with those of Hong (1996). In investigating the effects of using children's literature on mathematics achievement, Hong found that the results of a standardized mathematics achievement test indicated no differences in achievement between the experimental and control groups at the end of the study.

The present study also adds to research by determining whether student achievement gains were contaminated by variability in child aptitude or IQ. These statistically nonsignificant results indicated that individual child variability in IQ was not a major determinant of differences in achievement gains. Therefore, the use of a goal-oriented mathematics approach with young children such as the LMS approach may prove to be beneficial to all children regardless of individual variability in IQ.

The second research question asked if preschool teachers believed they were more effective in their mathematics instruction after implementing the LMS approach with young children. The findings of the content analysis affirmed that teachers believed they were more effective in their mathematics instruction after implementing the LMS approach. However, not only the teachers in the experimental (LMS) group, but also the teachers in the control group reported that they were more effective in their mathematics instruction after participating in the research study. This finding leads the researcher to believe that compensatory rivalry (the John Henry effect) occurred in the experiment. Gall, Borg, and Gall (1996) define compensatory rivalry as a situation in which control group participants perform beyond their usual level because they perceive they are in competition with the experimental group. If this phenomenon occurs, the lack of observed difference between the two groups (experimental and control) on the posttest can be attributed to the control group's unusual motivation rather than to a lack of treatment effects. Further, the researcher found that both groups of teachers believed the goals given to them at the beginning of the study were helpful in determining what mathematics skills are important for preschool children. Therefore, the researcher did not study the effects of true experimental and control conditions, but instead studied the effects of two experimental conditions. One experiment involved teachers using the planned LMS approach and the other experiment involved teachers using preschool mathematics goals in small and large group interaction with children.

Implications for Preschool Mathematics Practice

The findings of this study provide implications for preschool mathematics practice. First, finding no statistically significant difference between the LMS approach and other goal-oriented, regular preschool teaching methods indicates that the LMS approach is as effective an approach to mathematics learning with preschool children as other goal-oriented approaches. This finding leads to the implication that early childhood educators should involve children in a variety of mathematical experiences based on individual child goals, outcomes, and interests regardless of the particular instructional strategies employed. An important conclusion of the present study is that well-defined preschool mathematics outcomes are a vital part of the preschool curriculum. While researchers continue to build a bridge between research and practice in early childhood mathematics education through exploring the methodology of approaches such as the LMS approach, educators should challenge preschool children's capacities for mathematics through developmentally appropriate, integrated, and challenging teaching practices.

A second finding of the study also has implications for early childhood mathematics practice. This finding is related to teachers' perceptions of effectiveness in mathematics education and is three-fold:

a) all six teachers believed they were better preschool mathematics teachers after participating in the study,
b) all teachers believed that the children in their respective classrooms gained informal mathematics skills over the 10-week study, and
c) four of the six teachers attributed a child's lack of mathematics growth to either the child's lack of interest or lack of ability to attend to the activity.

The implications based on teacher beliefs clearly denote the importance of early childhood teacher training or staff development.

Preschool teachers should have knowledge about appropriate and challenging goals for early childhood mathematics. Furthermore, teachers should be educated on how to individualize mathematics goals to enhance learning for each child. The theoretical foundation of this study could serve as a basis for teacher training on individualization of mathematics goals. Vygotsky's explanation that good teaching is presenting material a little ahead of development suggests that learning precedes development (Vygotsky, 1962). Moreover, teachers following the Vygotskian approach scaffold children's instruction by identifying the zone of proximal development of each child. This study's finding supports the notion that as teachers understand appropriate and challenging goals for early childhood mathematics and are educated on how to individualize mathematics goals, children will gain mathematics skills during the early years. Finally, the finding related to children's lack of mathematics growth highlighted that four of six teachers attributed a child's lack of growth in math to either the child's lack of interest or lack of ability to attend to the activity. Therefore, it is important to note that preschool teachers need staff development and training in motivating students in area of mathematics. Understanding that young children differ in their level of interest in mathematics it is not only necessary for early childhood educators to identify children's strengths and weaknesses but also children's interests in order to better facilitate the early learning experiences children attend to and learn from during the preschool years.

Recommendations for Future Research

There are several recommendations for future research based on the findings of the present study. The recommendations include more in-depth study of children's literature and mathematics achievement, including replication of the LMS approach; research investigating preschool children's ability, achievement, and interest in mathematics; teachers' scaffolding techniques in preschool mathematics; and longitudinal mathematics research beginning during the preschool years.

First, there is a strong need for more in-depth study of the effective use of children's literature on mathematics achievement. The present body of research in the area of children's literature and mathematics achievement for young children is inconclusive. However, finding no statistically significant differences between the LMS approach and other goal-oriented, preschool teaching methods in the present study indicates the LMS approach is as effective an approach to mathematics learning with preschool children as other goal-oriented approaches. Therefore, the researcher recommends replication of the LMS approach with other groups of preschool children for a longer duration such as a school year. Using the sound methodology of the LMS approach that was created through a review of the literature of children's storybooks in mathematics education, mathematics manipulatives, and teacher scaffolding, future researchers could enhance the field of early childhood mathematics through continued study.

Second, there is a need for further research investigating preschool children's ability, aptitude, achievement, and interest in mathematics related to different types of teacher instruction. Even though children differ in their level of interest and ability in mathematics, children at any given developmental stage can learn to reason, formulate hypotheses, and problem-solve (Ward, 1995). The study finding highlighting that individual child variability in IQ was not a major determinant of differences in achievement gains challenges the notion of a mathematics approach as beneficial for only those children with high mathematics aptitude. Therefore, more research in needed in the use of goal-oriented mathematics approaches with all young children. Furthermore, the teachers in the present study believed that the preschool children in their classrooms worked with mathematics activities only when interested. However, the present study did not address children's interest in relation to the type of teacher instruction utilized. Pairing different instructional methods with children's specific mathematics interests would individualize preschool mathematics instruction and open a wide variety of research opportunities for early childhood mathematics.

Further, research is needed documenting teachers' scaffolding techniques in preschool mathematics. The work of Lev Vygotsky has become influential to mathematics teaching and learning with young children, especially in regard to teachers' scaffolding of children's learning (Charlesworth, 1997; Cobb, 1994). Although researchers initiated studies involving teacher scaffolding across various curriculum areas throughout the 1990s (Brodova & Leong, 1996; Wollman-Bonilla & Werchadlo, 1999), a review of recent literature found no recent studies involving teacher scaffolding of mathematics at the preschool level. The present study began what needs to continue as a thorough investigation of preschool teachers scaffolding of young children's mathematical thinking. One teacher in the present study using the LMS approach stated, "I do believe that it (the LMS approach) has helped me become a better preschool teacher in using the math skills because using this material showed us how to put it together and use it to the child's advantage". Qualitative methodology could aid in documenting teachers' scaffolding techniques related to children's mathematics.

Finally, the continued interest in mathematics achievement in the U.S. is likely to open up new opportunities for longitudinal research beginning during the preschool years. Early childhood mathematics research has longstanding importance in relation to children's cognitive development. Researchers should question, "Can children reach and master challenging mathematics without a firm and early foundation in the subject area?" Studying groups of children given challenging, yet meaningful mathematics experiences from the preschool years in comparison to children given unstructured mathematics play opportunities, researchers using longitudinal designs could open up rich discussion between mathematical pedagogues and early childhood experts alike offering significant discourse between the disciplines.

APPENDIX A

DESCRIPTION OF STUDY AND CONSENT FORMS

April 1, 2000

Dear Parents:

I am a doctoral candidate in the Department of Counseling, Development, and Higher Education at the University of North Texas. I have been given permission by Nancy Cotten, director of All-Saints Child Care and Learning Center, to conduct a ten-week research project investigating preschool mathematics achievement. Through this letter, I am requesting permission for your child to participate in my study. As mathematics education is now offered to more preschool-aged children, it is important that studies clarify what types of math instruction lead to student achievement. Therefore, results of this study will provide information on how teachers' classroom instruction can be improved to benefit children's mathematics achievement.

Your child's teacher will incorporate mathematics activities with specific learning outcomes into the children's regularly scheduled small and large group activities. Each participating child will be asked to leave the classroom once at both the beginning and end of the study with me or another familiar research assistant for testing purposes. Children will be taken out of the classroom only if they are comfortable and willing to do so. Children usually enjoy participating individually with a familiar adult, so I expect that your child will be enthusiastic about participating. At no time will children be pressured to participate in any of the activities. Furthermore, if any child expresses a desire to return to the classroom, the child will be immediately escorted back to the class.

There are no risks involved by your child participating in the study. The investigator will not reveal your child's name and no children's names will appear on any of the scoring sheets. All information will be kept strictly confidential and will be used for research purposes in statistical summaries only. You may withdraw your child from the study at any time. At the conclusion of the study, a summary of group results will be made available to all interested parents and teachers.

Please read the attached statement, sign in the space provided if you agree to have your child participate. Return the attached statement to your child's teacher. If you have any questions, please contact me via phone (940) 565-2719 or (940) 566-8683 or contact Dr. George S. Morrison in the Department of Counseling, Development, and Higher Education at (940) 565-4477. Thank you in advance for your support.

Sincerely,

Tisha L. Bennett

April 1, 2000

Dear Parents:

I am a doctoral candidate in the Department of Counseling, Development, and Higher Education at the University of North Texas. Dena Bruton-Claus, director and owner of Springbok Academy, has given me permission to conduct a ten-week research project investigating preschool mathematics achievement. Through this letter, I am requesting permission for your child to participate in my study. As mathematics education is now offered to more preschool-aged children, it is important that studies clarify what types of math instruction lead to student achievement. Therefore, results of this study will provide information on how teachers' classroom instruction can be improved to benefit children's mathematics achievement.

Your child's teacher will incorporate mathematics activities with specific learning outcomes into the children's regularly scheduled small and large group activities. Each participating child will be asked to leave the classroom once at both the beginning and end of the study with me or another familiar research assistant for testing purposes. Children will be taken out of the classroom only if they are comfortable and willing to do so. Children usually enjoy participating individually with a familiar adult, so I expect that your child will be enthusiastic about participating. At no time will children be pressured to participate in any of the activities. Furthermore, if any child expresses a desire to return to the classroom, the child will be immediately escorted back to the class.

There are no risks involved by your child participating in the study. The investigator will not reveal your child's name and no children's names will appear on any of the scoring sheets. All information will be kept strictly confidential and will be used for research purposes in statistical summaries only. You may withdraw your child from the study at any time. At the conclusion of the study, a summary of group results will be made available to all interested parents and teachers.

Please read the attached statement, sign in the space provided if you agree to have your child participate. Return the attached statement to your child's teacher. If you have any questions, please contact me via phone (940) 565-2719 or (940) 566-8683 or contact Dr. George S. Morrison in the Department of Counseling, Development, and Higher Education at (940) 565-4477. Thank you in advance for your support.

Sincerely,

Tisha L. Bennett

PARENT CONSENT FORM

I, ___________________________, agree that my preschool child, ________________, can participate in a project of mathematics achievement. As a participant in this study, I understand that my child will be asked to leave the classroom at both the beginning and end of the study with a familiar research assistant for testing purposes.

I have been informed that the investigator will not reveal my child's name and that no children's names will appear on any of the scoring sheets. Results of this project will not report the scores of any one child, but will utilize group averages and statistical summaries only. Individual results will not be made available to anyone.

I understand that there is no risk involved with my child participating in this study. Also, I may withdraw my child from participating in the study at any time. Furthermore, I understand that this study will provide information on how teachers' classroom instruction can be improved to benefit children's mathematics achievement.

I understand that the researcher will provide me a copy of this consent form. If I have questions or problems that arise in connection with my child's participation in this study, I may contact Tisha Bennett at (940) 565-2719 or (940) 566-8683, or Dr. George S. Morrison in the Department of Counseling, Development, and Higher Education at (940) 565-4477.

SIGNED: _________________________
(To be signed by Parent/Legal Guardian)

Date: ____________________________

April 1, 2000

Dear Teacher:

I am a doctoral candidate in the Department of Counseling, Development, and Higher Education at the University of North Texas. I have been given permission by Mrs. Nancy Cotten, director of All-Saints Child Care and Learning Center, to conduct a research project investigating preschool mathematics achievement. This project involves your voluntary participation in a ten-week academic intervention. You will be randomly selected to participate in either an experimental or control condition.

Your involvement in the study will include following lesson plans that address specific mathematics learning outcomes. You will be asked to implement both large and small group mathematics activities with the children in your classroom. Furthermore, your participation in the study involves a post-intervention interview with the researcher. This interview will be one to two hours in length and will take place wherever is convenient for you.

There is no personal risk or discomfort directly involved with this research and you are free to withdraw your consent and discontinue participation in this study at any time. The investigator will not reveal your name on any of the interview transcripts. All information will be kept strictly confidential and will be used for research purposes in statistical summaries only. At the conclusion of the study, a summary of group results will be made available to all interested teachers and parents.

Please read the attached statement and sign in the space provided. You will be given a copy of the signed consent form. If you have any questions, please contact me via phone (940) 565-2719 or (940) 566-8683 or contact Dr. George S. Morrison in the Department of Counseling, Development, and Higher Education at (940) 565-4477. Thank you in advance for your participation.

Sincerely,

Tisha L. Bennett

April 1, 2000

Dear Teacher:

I am a doctoral candidate in the Department of Counseling, Development, and Higher Education at the University of North Texas. I have been given permission by Mrs. Dena Bruton-Claus, director and owner of Springbok Academy, to conduct a research project investigating preschool mathematics achievement. This project involves your voluntary participation in a ten-week academic intervention. You will be randomly selected to participate in either an experimental or control condition.

Your involvement in the study will include following lesson plans that address specific mathematics learning outcomes. You will be asked to implement both large and small group mathematics activities with the children in your classroom. Furthermore, your participation in the study involves a post-intervention interview with the researcher. This interview will be one to two hours in length and will take place wherever is convenient for you.

There is no personal risk or discomfort directly involved with this research and you are free to withdraw your consent and discontinue participation in this study at any time. The investigator will not reveal your name on any of the interview transcripts. All information will be kept strictly confidential and will be used for research purposes in statistical summaries only. At the conclusion of the study, a summary of group results will be made available to all interested teachers and parents.

Please read the attached statement and sign in the space provided. You will be given a copy of the signed consent form. If you have any questions, please contact me via phone (940) 565-2719 or (940) 566-8683 or contact Dr. George S. Morrison in the Department of Counseling, Development, and Higher Education at (940) 565-4477. Thank you in advance for your participation.

Sincerely,

Tisha L. Bennett

Teacher Consent Form

I, _________________________, agree to participate in this study of children's mathematics achievement. The purpose of this study is to determine if preschool children's mathematics test scores can be improved through the implementation of an academic intervention.

As a participant, I understand that my involvement will include following a set of lesson plans and helping children meet learning outcomes. Also, I understand that I may be asked to implement both large and small group activities with the children in my classroom. Furthermore, I will participate in a post-intervention interview with the researcher. This interview will be one to two hours in length and will take place wherever is convenient for me.

I have been informed that the investigator will not reveal my name and that no children's names in my classroom will appear on any of the scoring sheets. Individual results will not be made available to anyone. All information will be kept strictly confidential and will be used for research purposes only.

I understand that there is no personal risk or discomfort directly involved with this research and that I am free to withdraw my consent and discontinue participation in this study at any time. I also understand that at the end of the study, the researcher will make a summary of group results available to me for my participation in the study.

If I have any questions or problems that arise in connection with my participation in this study, I should contact Tisha Bennett at (940) 565-2719 (work) or (940) 566-8683 (home) or Dr. George S. Morrison in the Department of Counseling, Development, and Higher Education at (940) 565-4477.

_______________ ____

(Date) (Participant Signature)

APPENDIX B

EXAMPLES OF LITERATURE-MATHEMATICS-SCAFFOLDING LESSON PLANS

Literature-Manipulatives-Scaffolding (LMS) Approach for Preschool Mathematics Achievement

1. Based on the use of children's literature as a springboard for mathematics learning, the LMS approach is a preschool mathematics intervention that lasts 10 weeks.

2. The LMS approach contains 10 weekly lessons. Each lesson has one or two learning outcome(s) and a daily plan for teachers to follow to help the children achieve the outcome(s).

3. Everyday of the week the teacher reads the same book to the children.

4. Wednesday through Friday of each week the teacher involves children in small group experiences during small group or center time.

5. Following the LMS approach takes a minimum of 2 hours per week with each child in large and small groups.

Monday:	15 minutes reading in large group
Tuesday:	15 minutes reading in large group
Wednesday:	15 minutes reading in large group; 15 minutes in small groups with manipulatives
Thursday:	15 minutes reading in large group; 15 minutes in small groups with manipulatives
Friday:	15 minutes reading in large group; 15 minutes in small groups with manipulatives

Children's Literature in the LMS Approach

The Button Box by Margarette S. Reid

Domino Addition by Lynette Long

The Doorbell Rang by Pat Hutchins

Fish Eyes by Lois Ehlert

How Many Feet in The Bed? by Diane Johnston Hamm

Inch by Inch by Leo Lionni

Mouse Count by Ellen Stoll Walsh

The Quilt by Ann Jonas

Sea Shapes by Suse MacDonald

So Many Cats by Beatrice Schenk de Regniers

Mathematics Manipulatives in the LMS Approach

1. Counting Mice Kit: Children practice one-to-one correspondence and addition with over 200 play gray mice, four plastic jars, and four laminated activity mats.

2. Number Sense Kit: Children practice counting from 1 to 12 and build number sense with 70 colored cat counters and four laminated activity mats.

3. Counting Pairs Kit: Children learn to count by twos with over 50 matching pairs of colored shoe counters and four laminated activity mats.

4. Quilt Patterns Kit: Children learn patterning and ordering with 168 vinyl quilt squares in 6 patterns and four laminated activity mats.

5. Sorting Fish Kit: Children practice counting with 126 play fish and four laminated activity mats.

6. Shapes Kit: Children sort and classify shapes with 100 foam pieces and four laminated activity mats. The shapes include squares, circles, triangles, rectangles, ovals, diamonds, hearts, stars, etc.

7. Measurement Kit: Children practice measuring, estimating, and sorting with 48 snap together inch worms and four laminated activity mats.

8. Domino Math Kit: Children practice matching and basic addition with 4 sets of 28 dominoes (1 set of each color: red, blue, green, and yellow) and four laminated activity mats.

9. Button Box Kit: Children sort and classify buttons. The kit includes an assortment of different sized and colored buttons and four laminated activity mats.

10. Doorbell Rang Kit: Children practice counting with a set of 12 chocolate chip cookie manipulatives and four material placemats.

Counting Mice Kit

includes the book **Mouse Count by Ellen Stoll Walsh**.

Children practice one-to-one correspondence and addition with over 200 play gray mice, four plastic jars, and four laminated activity mats.

Learning Outcome:	The child will count 10 mice. The child will use one-to-one correspondence to count 10 mice.

Counting Mice Kit – Monday
Learning Outcome: The child will count 10 mice. The child will use one-to-one correspondence when counting 10 mice.
1. Introduce and read Mouse Count to the children as a whole group. 2. Show the children the book. 3. Read the title and author on the front cover. 4. Have the children guess what they think the book will be about after looking at the cover of the book and hearing the title. 5. Read the book with expression, emphasizing important words or concept such as numbers (one, two, three, etc.) and mathematics terms such as the word "counting." 6. After reading the book, let the children ask questions about the story.

Counting Mice Kit – Tuesday
1. Ask the children if they can remember the title of Mouse Count from Monday's group reading. 2. Reread the book that was introduced on Monday. 3. After reading the book, introduce the concept of counting by having the children count the mice on the first pages of the book as you count with them and point to each mouse. 4. Emphasize the word "count", say "count" with me please. After counting with the children, tell them how many mice you counted. For example, say, "We counted ten mice". 5. Show the children one of the plastic jars full of mice manipulatives. 6. Explain to the children that on Wednesday (the next day at school) they will each get a turn to play with the little mice at a table with the teacher. They will get their own turn to count mice, like the snake did in the story (S1).

Counting Mice Kit – Wednesday

1. Ask the children if they can remember what happened in the story Mouse Count.
2. Reread the book that was introduced on both Monday and Tuesday.
3. Encourage the children to remember parts of the story by asking simple questions throughout your reading. For example, ask, “Can you tell me what the little mice did when the snake went to look for a big mouse to eat?”
4. During large group, show the children one of the plastic jars full of mice manipulatives.
5. Tell the children that each of them will get a turn to play with the mice, but that only four children can play with the teacher at one time (S1).
6. Count to the number four with the children while holding up each jar of mice or the four laminated activity mats. HINT: It is a good idea to only use 10 to 12 mice per child or per jar when first introducing the activity.
7. During free play or small group time, invite four children to play with the mice at any one time.
8. Let children openly explore the mice manipulatives.
9. Observe the children’s play with the manipulatives without directly influencing their play (S2). Note if they say things like, “Let’s count the mice.”

Counting Mice Kit – Thursday
1. Show the children the <u>Mouse Count</u> book and ask the children if they can remember what toys (manipulatives) they played with on Wednesday. Tell them that they will get to play with the mice again today (S1). 2. Reread <u>Mouse Count and</u> encourage the children to count with you when you read the number words in the story. 3. When working in small groups, tell the children that you would like them to do a special activity with math manipulatives (mice). 4. Explain simply that you would like them to count ten mice while touching each one with their finger (one-to-one correspondence). ***5.*** Through observation, determine the individual child's ZPD (S2). <u>Important:</u> Remember the lower end of the child's ZPD is the level at which the child can perform the activity independently (independent performance). The higher end of the child's ZPD is the maximum level the child can reach with help or assistance (assisted performance). 6. Older children (older 4s or 5-year-olds) may easily be able to count and point to 10 mice. If they are able to easily meet the learning outcome, make it more difficult by asking those children to recognize the numerals on the <u>Mouse Count</u> placemats and to place the number of mice on each numeral that matches the numeral (55 mice per jar will be needed). 7. Through observation, determine the older child's ZPD (S2) on the new task asked of the child. 8. After determining the child's ZPD, let the child work independently unless he or she asks specifically for adult help. Write down each child's ZPD on the form provided after Friday's lesson plan.

Counting Mice Kit – Friday
1. Briefly explain that this is the last day to read Mouse Count at school. Also, explain that this is the last day that the children will work with the toys related to that book in a small group. 2. Read Mouse Count for the last time in the large group. Let children read along with you when appropriate, such as repetitive phrases or important words. 3. When working in small groups, tell the children that you would like them to do a special activity with math manipulatives (mice). Do not ask them if they want to do the activity, tell them you need them to work with you. 4. Depending on the child's ZPD you observed on Thursday, choose the appropriate learning outcome, or task, for the child to attempt to achieve alone, scaffold the child's attempts to reach the goal as needed (S3,4,5,6). 5. If the child is unable to get the mice out of the jar on his or her own, then line them up to count them. You should simplify the activity for the child by placing ten mice in a row for the child to count (S3,5). 6. If the child is not able to reach the learning outcome because he or she is counting each mouse more than one time, use a verbal instruction and say, "Please count each mouse only one time (S4)". 7. Try to scaffold the child toward the main goal through verbal directions first. Then, if the child is not able to follow your directions, say, "Let me help you point and count the mice. Let's do it together" (S6). 8. Finally, if the child is not able to do the activity along with you, have the child observe you modeling or demonstrating the activity for him or her (S6). Then, have the child attempt the activity with you again.

Number Sense Kit

includes the book **<u>So Many Cats</u> by Beatrice Schenk de Regniers**.

Children practice counting from 1 to 12 and build number sense with 70 colored cat counters and four laminated activity mats.

Learning Outcomes:	The child will count 12 cats. The child will use one-to-one correspondence when counting 12 cats.

Number Sense Kit – Monday
Learning Outcomes: The child will count 12 cats. The child will use one-to-one correspondence when counting 12 cats.
1. Introduce and read <u>So Many Cats</u> to the children as a whole group. 2. Show the children the book. 3. Read the title and author on the front cover. 4. Have the children guess what they think the book will be about after looking at the cover of the book and hearing the title. 5. Read the book with expression, emphasizing important words or concept such as numbers (one, two, three, etc.) and mathematics terms such as the word "counting." 6. After reading the book, let the children ask questions about the story.

Number Sense Kit – Tuesday
1. Ask the children if they can remember the title of So Many Cats from Monday's group reading. 2. Reread the book that was introduced on Monday. 3. After reading the book, introduce the concept of counting by having the children count the cats on the first several pages of the book as you count with them and point to each cat. 4. Emphasize the word "count", say "count" with me please. After counting with the children, tell them how many cats you counted. For example, say, "We counted twelve cats". 5. Open and show the children the box full of cat manipulatives. 6. Explain to the children that on Wednesday (the next day at school) they will each get a turn to play with the little cats at a table with the teacher. They will get their own turn to count cats, like they did in the story (S1).

Number Sense Kit – Wednesday
1. Ask the children if they can remember what happened in the story So Many Cats. 2. Reread the book that was introduced on both Monday and Tuesday. 3. Encourage the children to remember parts of the story by asking simple questions throughout your reading. For example, ask, "Can you tell me how many kittens the mother cat had? Three, that's right." 4. During large group, show the children the box full of cat manipulatives. 5. Tell the children that each of them will get a turn to play with the cats, but that only four children can play with the teacher at one time (S1). 6. Count to the number four with the children while holding up four cats or the four laminated activity mats. 7. During free play or small group time, invite four children to play with the cats at any one time. 8. Let children openly explore twelve cat manipulatives. 9. Observe the children's play with the manipulatives without directly influencing their play (S2). Note if they say things like, "Let's count the cats."

Number Sense Kit – Thursday
1. Show the children the <u>So Many Cats</u> book and ask the children if they can remember what toys (manipulatives) they played with on Wednesday. Tell them that they will get to play with the cats again today (S1). 2. Reread <u>So Many Cats</u> and encourage the children to count with you when you read the number words in the story. 3. When working in small groups, tell the children that you would like them to do a special activity with math manipulatives (cats). 4. Explain simply that you would like them to count twelve cats while touching each one with their finger (one-to-one correspondence). 5. Through observation, determine the individual child's ZPD (S2). <u>Important:</u> Remember the lower end of the child's ZPD is the level at which the child can perform the activity independently (independent performance). The higher end of the child's ZPD is the maximum level the child can reach with help or assistance (assisted performance). 6. After determining the child's ZPD, let the child work independently unless he or she asks specifically for adult help. Write down each child's ZPD on the form provided after Friday's lesson plan.

Number Sense Kit – Friday

1. Briefly explain that this is the last day to read So Many Cats at school. Also, explain that this is the last day that the children will work with the toys related to that book in a small group.
2. Read So Many Cats for the last time in the large group. Let children read along with you when appropriate, such as when counting cats.
3. When working in small groups, tell the children that you would like them to do a special activity with math manipulatives (mice). Do not ask them if they want to do the activity, tell them you need them to work with you.
4. Depending on the child's ZPD you observed on Thursday, choose the appropriate learning outcome, or task, for the child to attempt to achieve alone, scaffold the child's attempts to reach the goal as needed (S3,4,5,6).
5. If the child is unable to stand the cats up on the mat, then count them. You should simplify the activity for the child by placing twelve cats in a row for the child to count (S3,5).
6. If the child is not able to reach the learning outcome because he or she is counting each cat more than one time, use a verbal instruction and say, "Please count each cat only one time" (S4). A more general direction would be saying, "Count slowly and carefully please".
7. Try to scaffold the child toward the main goal through verbal directions first. If the child is not able to follow your verbal directions, say, "Let me help you point and count the cats. Let's do it together" (S6).
8. Finally, if the child is not able to do the activity along with you, have the child observe you modeling or demonstrating the activity for him or her (S6). Then, have the child attempt the activity with you again.

Counting Pairs Kit

includes the book **How Many Feet in The Bed?** by Diane Johnston Hamm.

Children learn to count by twos with over 50 matching pairs of colored shoe counters and four laminated activity mats.

Learning Outcome: The child will count pairs of shoes.
The child will match shoes by one attribute.

Counting Pairs Kit – Monday
Learning Outcomes: The child will count pairs of shoes. The child will match shoes by one attribute.
1. Introduce and read <u>How Many Feet in The Bed?</u> to the children as a whole group. 2. Show the children the book. 3. Read the title and author on the front cover. 4. Have the children guess what they think the book will be about after looking at the cover of the book and hearing the title. 5. Read the book with expression, emphasizing important words or concepts. 6. Point out which feet look alike using the words little and big to differentiate the size of the feet. 7. After reading the book, let the children ask questions about the story.

Counting Pairs Kit – Tuesday
1. Ask the children if they can remember the title of <u>How Many Feet in The Bed?</u> from Monday's group reading. 2. Reread the book that was introduced on Monday. 3. After reading the book, introduce the concept of pairs by having the children count the pairs of the feet shown in the book as you count with them and point to pair of feet. Explain simply that a pair is two of something (a set of two), like a pair of hands, ears, eyes, feet, or shoes. If you have two hands, you only have one pair of hands. 4. Emphasize the words "count" and "pairs", say count with me please. After counting with the children, tell them how many feet you counted and how many pairs of feet you counted. For example, say, "We <u>counted</u> 5 pairs of feet that means we counted 10 feet". 5. Open and show the children the box full of colored shoes. 6. Explain to the children that on Wednesday (the next day at school) they will each get a turn to play with the colored shoes at a table with the teacher. They will get their own turn to match the shoes that look alike and count pairs of shoes, like they counted feet in the story (S1).

Counting Pairs Kit – Wednesday

1. Ask the children if they can remember what happened in the story How Many Feet in The Bed?
2. Reread the book that was introduced on both Monday and Tuesday.
3. Encourage the children to remember parts of the story by asking simple questions throughout your reading. For example, ask, "Can you tell me how many feet are in the bed or how many pairs of feet?"
4. During large group, show the children the box of shoe manipulatives.
5. Tell the children that each of them will get a turn to play with the colored shoes, but that only four children can play with the teacher at one time (S1).
6. Count to the number four with the children while holding up four shoes or the four laminated activity mats.
7. During free play or small group time, invite four children to play with the shoes at any one time. Give each child 8 to 10 shoes, or 4 pairs of shoes.
8. Let children openly explore the shoe manipulatives.
9. Observe the children's play with the manipulatives without directly influencing their play (S2). Note if they say things like, "Let's count pairs of shoes."

Counting Pairs Kit – Thursday

1. Show the children the How Many Feet in The Bed? book and ask the children if they can remember what toys (manipulatives) they played with on Wednesday. Tell them that they will get to play with the shoes again today (S1).

2. Reread How Many Feet in The Bed? and encourage the children to count with you when you read the number words in the story.

3. When working in small groups, tell the children that you would like them to do a special activity with the shoes (math manipulatives).

4. Give each child all shoes of the same color (i.e., all black shoes or red shoes – 4 pairs total). Explain simply that you would like them to match the shoes that look alike.

5. After asking the children to match the similar shoes, have them count the number of shoes they have (all children should have eight shoes). Then ask the children to count the pairs, or sets of two shoes.

6. Through observation, determine the individual child's ZPD (S2) for matching and for counting pairs. Important: Remember the lower end of the child's ZPD is the level at which the child can perform the activity independently (independent performance). The higher end of the child's ZPD is the maximum level the child can reach with help or assistance (assisted performance).

7. After determining the child's ZPD, let the child work independently unless he or she asks specifically for adult help. Write down each child's ZPD on the form provided after Friday's lesson plan.

Counting Pairs Kit – Friday
1. Briefly explain that this is the last day to read How Many Feet in The Bed? at school. Also, explain that this is the last day that the children will work with the toys related to that book in a small group. 2. Read How Many Feet in The Bed? for the last time in the large group. Let children read along with you when appropriate, such as when counting feet. 3. When working in small groups, tell the children that you would like them to do a special activity with math manipulatives (shoes). Do not ask them if they want to do the activity, tell them you need them to work with you. 4. Depending on the child's ZPD you observed on Thursday, choose the appropriate learning outcome, or task, for the child to attempt to achieve alone, scaffold the child's attempts to reach the goal as needed (S3,4,5,6). For example, if the child was easily able to match the shoes by one attribute then concentrate on the other learning outcome of counting pairs of shoes. 5. If the child is unable to match the shoes, then count them by pairs. You should simplify the activity for the child by placing the shoes together in pairs for the child to count (S3,5). 6. If the child is not able to reach the learning outcome of counting pairs because he or she is counting each shoe individually, use a verbal instruction and say, "Please count each pair (set) of two shoes as one number" (S4). A more general direction would be saying, "Count pairs of shoes slowly and carefully please". 7. Try to scaffold the child toward the goal through verbal directions first. If the child is not able to follow your verbal directions, say, "Let me help you point and count the pairs of shoes. Let's do it together" (S5). 8. Finally, if the child is not able to do the activity along with you, have the child observe you modeling or demonstrating the activity for him or her (S6). Show the child how to match shoes that look alike and then how to count the pairs of shoes. Then, have the child attempt the activity with you again.

APPENDIX C

SCAFFOLDING PROCEDURE FOR EXPERIMENTAL GROUP TEACHERS

Six Scaffolding Techniques in the LMS Approach

1. Recruit or enlist the child's interest in activity. Always let the child play with and explore materials openly before asking him or her to participate in a specific task with materials.

2. Observe the child in the context of the activity to determine the child's zone of proximal development (ZPD).

<u>ZPD</u> = It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers.

<u>Important:</u> Remember the lower end of the child's ZPD is the level at which the child can perform the activity independently (independent performance). The higher end of the child's ZPD is the maximum level the child can reach with help or assistance (assisted performance).

3. Simplify the activity for the child by reducing the number of steps necessary to complete a given task.

4. Direct maintenance: Keep the child in pursuit of the goal.
   a. Provide general verbal instruction such as "Count slowly."
   b. Provide specific verbal instruction such as "You need one more."

5. Mark critical features of the task or activity.
   a. Indicate the material needed to complete the activity by pointing to and using verbal labels.
   b. Provide the material and place it where needed to best accomplish the learning outcome.

6. Demonstrate or model solutions to the problem or activity.

Important Points to Remember about Scaffolding

1. The goal of the teacher in scaffolding a child's learning is to always allow for the child to do as much as possible by him or herself without teacher intervention.

2. Always use verbal instruction first before intervening more directly in a child's activity.

3. Gradually reduce teacher support when the child becomes capable of more independent performance on a particular task.

4. In the weekly lesson plans, each of the six main scaffolding techniques has a label to highlight its importance. For example, when the teacher recruits or enlists the child's interest in an activity, this scaffolding technique has a (S1) label.

APPENDIX D

CHILD LEARNING OUTCOMES FOR CONTROL GROUP TEACHERS

STUDY OF PRESCHOOL MATHEMATICS

1. The teacher will spend approximately 2 hours per week with each child in large and small group activity.

Monday:	15 minutes in large group
Tuesday:	15 minutes in large group
Wednesday:	15 minutes in large group; 15 minutes in small groups
Thursday:	15 minutes in large group; 15 minutes in small groups
Friday:	15 minutes in large group; 15 minutes in small groups

2. The teacher will use normal, preschool teaching methods to help the children achieve the prescribed mathematics learning outcomes for each week of the ten-week intervention.

3. The teacher will list large and small group activities done on a daily basis on the pages provided highlighting the activities that emphasize the learning outcomes specified for the week.

WEEK 1 – Counting

Learning Outcomes:

1. The child will count numbers 1-10 (rote counting).
2. The child will use one-to-one correspondence to count numbers 1-10 (rational counting).

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 2 - Counting

Learning Outcomes:

1. The child will count numbers 1-12.
2. The child will use one-to-one correspondence to count numbers 1-12.

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 3 – Counting Pairs & Matching

Learning Outcome:

1. The child will count pairs of objects.
2. The child will match objects by one attribute such as size, shape, color, or style.

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 4 - Patterning

Learning Outcomes:

1. The child will finish a pattern started by the teacher.
2. The child will create a pattern.

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 5 - Sorting

Learning Outcomes:

1. The child will sort by color.
2. The child will sort by shape or style.

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 6 - SHAPES

Learning Outcomes:

1. The child will sort shapes.
2. The child will identify four out of five shapes by name.

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 7 - Measuring

Learning Outcomes:

1. The child will measure an object.
2. After measuring two objects, the child will point to the longest of the objects.

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 8 – More Than & Zero

Learning Outcomes:
1. The child will use the term “more than” in comparing concrete objects.
2. The child will recognize and describe the concept of zero (meaning there are none).

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 9 – Sorting & Classifying

Learning Outcomes:

1. The child will sort by size.
2. The child will classify objects by a single attribute.

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

WEEK 10 – Counting

Learning Outcome:

1. The child will count numbers 1-12.
2. The child will share (divide) 12 objects equally between 4 children (or into 4 groups).

	Large Group Activity	Small Group Activities
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		

- Fill in the chart provided with your daily activities for both large and small group learning.
- Label by number the activities that relate to the specific numbered learning outcomes above. For example, if the children participated in a large group counting activity on Monday, write the name or a short description of the activity and place a number (1) by the activity.

APPENDIX E

DEMOGRAPHIC INFORMATION

Child Information

ID# _________

Child's Name: ________________________
Teacher's Name: ________________________

Date of Birth:______
Gender: ________

Primary Language:	English
(circle)	Spanish
	Korean
	Chinese
	Japanese
	Vietnamese
	Other: __________

Race/Culture:	African-American
(circle)	Asian
	Caucasian
	Hispanic
	Indian
	Other: __________

APPENDIX F

INTERVIEW QUESTIONS

Main question:

Do preschool teachers believe they are more effective in their mathematics instruction after implementing the LMS approach with young children?

Interview questions for both groups of teachers:

1. Before this study, what types of mathematics-related activities did you use with the children in your classroom?
2. Before this study, what specific mathematics goals did you have for the children in your classroom?
3. Before this study, did you use books and manipulative materials to teach the children in your classroom mathematics? If so, what materials did you use?
4. Do you believe that the children in your classroom gained skills in mathematics over the 10-week study? How? Give examples.
5. Use one child and describe his or her most outstanding advances in mathematics over the 10-week study.
6. Describe one child's lack of mathematics growth over the 10-week study.

Experimental teachers:

7. Do you believe you are a better preschool mathematics teacher after implementing the LMS approach with the children in your classroom? If so, in what ways are you better able to teach math now than before participating in this study?
8. Did the LMS approach help you determine what mathematics skills are important for children to acquire during the preschool years?
9. What were the children's two favorite books and manipulatives during the study? Why?
10. How did you adapt the LMS approach to accommodate children's learning needs?

Control teachers:

11. Do you believe that you are a better preschool mathematics teacher after implementing activities based on specific goals with the children in your classroom? If so, in what ways are you better able to teach math now than before participating in this study?
12. Did the specific goals given to you in this study help you determine what mathematics skills are important for children to acquire during the preschool years?
13. What were the children's two favorite mathematics activities during the study? Why?
14. How did you adapt the specified goals to accommodate children's learning needs?

REFERENCE LIST

An Action Strategy for Improving Achievement in Mathematics and Science (1998). Executive Summary. [Online]. Available: http://www.ed.gov/pubs/12TIMSS/ execsum.html

American Association for the Advancement of Science. (1984). A report on the crisis in mathematics and science education: What can be done now? New York: J. C. Crimmins.

Balas, A. K. (1997). The reading and mathematics connection. ERIC Digest (CSMEE Digest 97-2). [Online]. Available: http://www.ericse.org/digests/dse97-2.html

Balfanz, R.(1999). Why do we teach young children so little mathematics: Some historical considerations. In. J. V. Copley (Ed.), Mathematics in the early years (pp. 3 -10). Reston, VA: National Council of Teachers of Mathematics.

Baroody, A. J. (1989). Manipulatives don't come with guarantees. Arithmetic Teacher, 37 (2), 4-5.

Baroody, A. J. (1993). Fostering the mathematical learning of young children. In B. Spodek (Ed.), Handbook of research on the education of young children (pp. 151-175). New York: Macmillan.

Baroody, A. J. (2000). Does mathematics instruction for three- to five-year-olds really make sense? Young Children, 55 (4), 61-67.

Bass, C. (1990). Comparability of the WPPSI-R and the Stanford-Binet: Fourth edition. Unpublished master's thesis. University of North Texas, Denton.

Battista, M. T. (1999). The mathematical miseducation of America's youth: Ignoring research and scientific study in education. Phi Delta Kappan, 80 (6), 424-433.

Benson, T. R., & Downing, J. E. (1999). Rejuvenate math and science- Revisit children's literature. Dimensions of Early Childhood, 27 (2), 9-15.

Berk, L. E. (1994). Vygotsky's theory: The importance of make-believe play. Young Children, 50 (1), 30-39.

Berk, L. E. (1999). Infants and children: Prenatal through middle childhood (3rd ed.). Needham Heights, MA: Allyn and Bacon.

Bodrova, E., & Leong, D. L. (1996). Tools of the mind: The Vygotskian approach to early childhood education. Englewood Cliffs, New Jersey: Merrill/Prentice Hall.

Braddon, K. L., Hall, N. J., & Taylor, D. (1993). Math through children's literature. Reston, Virginia: National Council of Teachers of Mathematics.

Bredekamp, S., & Copple, C. (Eds.) (1997). Developmentally appropriate practice in early childhood programs (Rev. ed.). Washington, D.C.: National Association for the Education of Young Children.

Bruner, J. (1983). Vygotsky's zone of proximal development: The hidden agenda. New Directions for Child Development, 23, 93-97.

Bush, G. (1991). America 2000: An overview. United States: Committee on Education and Labor.

Carnegie Corporation of New York. (1994). Starting points: Meeting the needs of our youngest children (abridged version). New York: Author. [Online]. Available: http://www.carnegie.org/starting_points/

Center for the Assessment of Educational Progress. (1989). A world of differences. Princeton, NJ: Educational Testing Service.

Charlesworth, R. (1997). Mathematics in the developmentally appropriate integrated classroom. In C. H. Hart, D. C. Burt, & R. Charlesworth, (Eds.), Integrated curriculum and developmentally appropriate practice: Birth to age eight (pp. 51-73). New York: State University of New York Press.

Charlesworth, R. (2000). Experiences in math for young children (4^{th} ed.). Albany, NY: Delmar.

Clinton, B. (1999). Letter from President Clinton. [Online]. Available: http://www.ed.gov/americacounts/letter.html

Clements, D. H. (1999). 'Concrete' manipulatives, concrete ideas. Contemporary Issues in Early Childhood, 1 (1), 45-60.

Clements, D. H., Swaminathan, S., Hannibal, M. A. Z., & Sarama, J. (1999). Young children's concepts of shape. Journal for Research in Mathematics Education, 30 (2), 192-212.

Cobb, P. (1994). Where is the mind? Constructivist and sociocultural perspectives on mathematics development. Educational Researcher, 23 (7), 13-20.

Conner, D. B., Knight, D. K., & Cross, D. R. (1997). Mothers' and fathers' scaffolding of their 2-year-olds during problem-solving and literacy interactions. British Journal of Developmental Psychology, 15, 323-338.

Cooney, T. J., & Hirsch, C. R. (Eds.). (1990). Teaching and learning mathematics in the 1990's. Reston, Virginia: National Council of Teachers of Mathematics.

Copley, J. V. (Ed.). (1999). Mathematics in the early years. Reston, VA: National Council of Teachers of Mathematics.

Dehaene, S. (1997). The number sense: How the mind creates mathematics. New York: Oxford University Press.

De Regniers, B. S. (1988). So many cats! New York: Clarion Books.

Dienes, Z. P., & Golding, E. W. (1971). Approach to modern mathematics. New York: Herder & Herder.

Dixon-Krauss, L. (1996). Vygotsky in the classroom: Mediated literacy instruction and assessment. White Plains, New York: Longman.

Educational Reporter. (1997). Hillary promotes early childhood intervention. [Online]. Available: http://www.eagleforum.org/educate/1997/may97/early.html

Edwards, T. G. (1994). Current reform efforts in mathematics education. In ERIC/ CSMEE digest [On-line]. Available: http://www.enc.org/reform/journals/ENC2430/nf_ 2430cnts.htm

Ehlert, L. (1990). Fish eyes: A book you can count on. Orlando, FL: Harcourt Brace Jovanovich.

Fleer, M. (1992). Identifying teacher-child interaction which scaffolds scientific thinking in young children. Science Education, 76 (4), 373-397.

Gall, M. D., Borg, W. R., Gall J. P. (1996). Educational research: An introduction (6th ed.). White Plains, NY: Longman.

Geary, D. C. (1994). Children's mathematical development. Washington, DC: American Psychological Association.

Gelman, R., & Gallistel, C. R. (1978). The child's understanding of number. Cambridge, MA: Harvard University Press.

Ginsburg, H. P., & Baron, J. (1993). Cognition: Young children's construction of mathematics. In R. J. Jensen (Ed.), Research ideas for the classroom: Early childhood mathematics (pp. 3-21). Reston, VA: National Council of Teachers of Mathematics.

Ginsburg, H. P. & Baroody, A. J. (1990). Test of Early Mathematics Ability (2nd ed.). Austin, TX: Proed.

Goals 2000: Implementing standards-based reform. (1998). [Online]. Available: www.ed.gov/pubs/G2K.Reforming/g2ch3.html (April 21, 1999).

Goldman, M. (1998). Time to solve the math education equation. Education week on the web. [Online]. Available: http://www.edweek.org/ew/vol-17/34gold.h17

Graham, T. A., Nash, C. & Paul, K. (1997). Young children's exposure to mathematics: The child care context. Early Childhood Education Journal, 25 (1), 31-38.

Grant, S. G., Peterson, P. L., & Shojgreen-Downer, A. (1996). Learning to teach mathematics in the context of system reform. American Educational Research Journal, 33 (2), 509-541.

Hagen, E., Delaney, E., & Hopkins, T. (1987). Stanford-Binet intelligence scale examiner's handbook: An expanded guide for fourth edition users. Chicago, IL: Chicago Riverside.

Hamm, D. J. (1994). How many feet in the bed? New York: Simon & Schuster Books for Young Readers.

Harsh, A. (1987). Teach mathematics with children's literature. Young Children, 42

(6), 24-29.

Hartshorn R., & Boren, S. (1990). Experiential learning of mathematics: Using manipulatives. ERIC Digest (ED 1.302: M 42/4)

Hiebert, J., & Carpenter, T. P. (1992). Learning and teaching with understanding. In D. A. Grouws (Ed.), Handbook of Research in Mathematics Teaching and Learning (pp.65-97). New York: Macmillan.

Hiebert, J., Carpenter, T. P., Fennema, E., Fuson, K. C., Wearne, D., Murray, H., Olivier, A., & Human, P. (1997). Making sense: Teaching and learning mathematics with understanding. Portsmouth, NH: Heinemann.

Hong, H. (1996). Effects of mathematics learning through children's literature on math achievement and dispositional outcomes. Early Childhood Research Quarterly, 11, 477-494.

Hong, H. (1999). Using storybooks to help young children make sense of mathematics. In. J. V. Copley (Ed.), Mathematics in the early years (pp. 162-168). Reston, VA: National Council of Teachers of Mathematics.

Horn, J. L. & Cattell, R. B. (1966). Refinement and test of the theory of fluid and crystallized general intelligence. Journal of Educational Psychology, 57, 253-70.

House, P. A. (1995). 1995 Yearbook: Connecting mathematics across the curriculum. Reston, VA: National Council of Teachers of Mathematics.

Hutchins, P. (1986). The doorbell rang. New York: Greenwillow Books.

Jacobson, L. (1998, March 11). Experts promote math, science for preschoolers. Education week on the web. [Online]. Available://www.edweek.org/ew/vol-

17/26early.h17

Jacobson, L. (1998). Preschooler's education takes center stage. Education Week, 17 (32), 1, 14-15.

Jennings, C. M., Jennings, J. E., Richey, J., & Dixon-Krauss, L. (1992). Increasing interest and achievement in mathematics through children's literature. Early Childhood Research Quarterly, 7, 263-276.

Jensen, R. J. (Ed.). (1995). Research ideas for the classroom: Early childhood mathematics. Reston, VA: National Council of Teachers of Mathematics.

Jonas, A. (1994). The quilt. New York: Puffin books.

Kagan, S. L., & Bowman, B. T. (1997). Leadership in early care and education: Issues and challenges. In S. L. Kagan & B. T. Bowman (Eds.), Leadership in early care and education. (pp. 3-8). Washington, D.C.: National Association for the Education of Young Children.

Kamii, C. (1985). Young children reinvent arithmetic: Implications of Piaget's theory. New York: Teacher's College Press.

Kennedy, L. M., & Tipps, S. (1994). Guiding children's learning of mathematics (7th ed.). Belmont, CA: Wadsworth.

Laurent, J., Swerdlik, M., & Ryburn, M. (1992). Review of validity research on the Stanford-Binet Intelligence Scale: Fourth Edition. Psychological Assessment, 4 (1), 102-112.

Lionni, L. (1995). Inch by inch. New York: Mulberry.

Long, L. (1996). Domino addition. Watertown, MA: Charlesbridge.

MacDonald, S. (1994). Sea shapes. San Diego, CA: Gulliver Books.

Martin, L. E., & Reutzel, D. R. (1996). Scaffolding books for children: Mothers' metacognitive decisions. Reading Psychology, 17, 159-180.

Mathematical Science Education Board of the National Research Council. (1990). Reshaping school mathematics: A philosophy and framework for curriculum. Washington, DC: National Academy Press.

McDonnell, L.M., McLaughlin, M.J., & Morison, P. (Eds.). (1997). Educating one & all: Students with disabilities and standards-based reform/Committee on Goals 2000 and the Inclusion of Students with Disabilities, Board on Testing and Assessment, Commission on Behavioral and Social Sciences and Education, National Research Council. Washington, DC: National Academy Press.

McMath, J., & King, M. A. (1994). Using picture books to teach mathematical concepts. Day Care and Early Education, 18-22.

McNeil, J. D. (1985). Curriculum: A comprehensive introduction (3rd ed.). Boston: Little, Brown, & Co.

Millican, B. R. (1994). The effects of writing-to-learn tasks on achievement and attitude in mathematics. Unpublished master's thesis. University of North Texas, Denton.

Mix, K. S., Levine, S. C., & Huttenlocher, J. (1999). Early fraction calculation ability. Developmental Psychology, 35, 164-174.

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. Washington, DC: U.S. Government Printing Office.

National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, Virginia: Author.

National Council of Teachers of Mathematics. (1991). Early childhood mathematics education. Reston, Virginia: Author.

National Council of Teachers of Mathematics. (1998). Principles and standards for school mathematics: Discussion draft. Reston, Virginia: Author.

National Governors Association. (2000). NGA Policy: Child Care and Early Education Preamble. [Online]. Available: http://www.nga.org/Pubs/Policies/HR/hr21.asp

National Research Council. (1989). Everybody counts: A report on the future of mathematics education. Washington, D.C.: National Academy Press.

Nunes, T., & Bryant, P. (1996). Children doing mathematics. Cambridge, MA: Blackwell.

Piaget, J. (1965). The child's conception of number. New York: Norton.

Pratt, M., Kerig, P., Cowan, P., & Cowan, C. (1988). Mothers and fathers teaching 3-year-olds: Authoritative parenting and adult scaffolding of young children's learning. Developmental Psychology, 24, 832-839.

Prekindergarten Curriculum Guidelines. (2000). Texas Education Agency. [Online]. Available://www.tea.state.tx.us/curriculum/early/prekguide.html

Press release: Trend report shows students making progress in math, science; Reading skills stable, writing results mixed. (1997). [Online]. Available: http://www.nces.gov/Pressrelease/trend96.html

Price, G. G. (1989). Research in review: Mathematics in early childhood. Young Children, 44 (4), 53-58.

Proed. (1999). Test of Early Mathematics Ability. [Online]. Available: http:// www.proedinc.com/store/895.html

Ravitch, D. (1995). National standards in American education: A citizen's guide. Washington, DC: The Brookings Institution.

Reid, M. S. (1990). The button box. New York: Dutton Children's Books.

Reese, C. M., Miller, K. E., Mazzeo, J., & Dossey, J. A. (1997). NAEP 1996 Mathematics Report Card for the Nation and the States: Executive Summary. [Online]. Available: http://nces.ed.gov/nationsreportcard/96report/97488.shtml

Resnick, L. B. (1989). Developing mathematical knowledge. American Psychologist, 44 (2), 162-169.

Secada, W. (1990). The challenges of a changing world for mathematics education. In T. J. Cooney & C. R. Hirsch (Eds.), Teaching and learning mathematics in the 1990's. Reston, Virginia: National Council of Teachers of Mathematics.

Seifert, K. L. (1993). Cognitive development and early childhood education. In B. Spodek (Ed.), Handbook of research on the education of young children (pp.10-15). New York: Macmillan.

Schulman, K., Blank, H., & Ewen, D. (1999). State prekindergarten initiatives: A varied picture of states' decisions affecting availability, quality, and access. Young Children, 54 (6), 38-41.

Schiro, M. (1997). Integrating children's literature and mathematics in the classroom. New York: Teachers College Press.

Shaw, J., & Blake, S. (1998). Mathematics for young children. Upper Saddle River, New Jersey: Prentice-Hall.

Shore, R. (1997). Rethinking the brain. New York: Families and Work Institute.

Sophian C., & McCorgray, P. (1994). Part-whole knowledge and early arithmetic problem-solving. Cognition and instruction, 12, 3-33.

Sowell, E. J. (1989). Effects of manipulative materials in mathematics instruction. Journal for Research in Mathematics Education, 20, 498-505.

Steen, L. A. (Ed.) (1990). On the shoulders of giants: New approaches to numeracy. Washington, D.C.: National Academy Press.

Stevenson, H. W., Lee, S. Y., & Stigler, J. W. (1986). Mathematics achievement of Chinese, Japanese, and American children. Science, 231, 693-699.

Suydam, M. N., & Higgins, J. L. (1977). Activity-based learning in elementary school mathematics: Recommendations from research. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 144 840)

Sylvester, B. N. (1989). First-year teacher usage of manipulatives in mathematics instruction: A case study. Unpublished doctoral dissertation. University of North Texas, Denton.

Taylor, B. (1995). A child goes forth. Upper Saddle River, NJ: Prentice Hall.

The Condition of Education: Introduction. (1996). NCES/Pinkerton Computer

Consultants. [On-line]. Available: http://nces.ed.gov/pubsold/ce96/c96003.html

The Seven Priorities of the U.S. Department of Education. (1997). [Online]. Available: http://www.ed.gov/updates/7priorities/part4.html

Thorndike, E. L. (1922). The psychology of arithmetic. New York: Macmillan.

Thorndike, R. L., Hagen, E. P., & Sattler, J. M. (1986). The Stanford-Binet intelligence scale (4th ed): Guide for administering and scoring. Chicago, IL: Riverside.

Trafton, P. R. & Shulte, A. P. (1989). New Directions for Elementary School Mathematics: 1989 National Council of Teachers of Mathematics Yearbook. Reston, Virginia: National Council of Teacher of Mathematics.

U. S. Department of Education (1995, October). Statistics in brief: Child care and early education program participation of infants, toddlers, and preschoolers (NCES 95-824). Washington, DC: U.S. Government Printing Office.

U. S. Department of Education. (1999). Early childhood: Where learning begins mathematics. Washington, DC: Author.

U.S. Department of Labor. (1999). Futurework: Trends and challenges for work in the 21st century. [Online]. Available: http://www.dol.gov/dol/asp/public/futurework/report.htm

U.S. TIMSS Summary of Findings (1999). U.S. National Research Center. [Online]. Available: http://ustimss.msu.edu/summary.htm

Vygotsky, L. S. (1962). Thought and language. Cambridge, MA: MIT Press.

Walsh, E. S. (1991). Mouse count. San Diego, CA: Harcourt Brace & Company.

Ward, C. D. (1995). Meaningful mathematics with young children. Dimensions of

Early Childhood, 23 (2), 7-11.

Welchman-Tischler, R. W. (1992). How to use children's literature to teach mathematics. Reston, VA: National Council of Teachers of Mathematics.

White, C. S., & Manning, B. H. (1994). The effects of verbal scaffolding instruction on young children's private speech and problem-solving capabilities. Instructional Science, 22, 39-59.

Whitin, D. J. (1994). Literature and mathematics in preschool and primary: The right connection. Young Children, 49 (2), 4-11.

Whitin, D. J., Mills, H., O'Keefe, T., & Thiessen, D. (1994). Exploring subject areas with a counting book. Teaching Children Mathematics, 170-174.

Whitin, D. J., & Wilde, S. (1992). Read any good math lately?: Children's books for mathematical learning, K-6. Portsmouth, NH: Heinemann.

Wollman-Bonilla, J. E., & Werchadlo, B. (1999). Teacher and peer roles in scaffolding first graders' responses to literature. The Reading Teacher, 52 (6) 598-607.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. Journal of Child Psychology and Psychiatry, 17, 89-100.

Wood, D., & Middleton, D. (1975). A study of assisted problem-solving. British Journal of Psychology, 66 (2), 181-191.

Zarra, J. (1999). Using manipulatives to retell a story within a preschool disabilities setting. (ED 427 382)